SGW-59564
Revision 0

Engineering Evaluation of the 200 West Pump and Treat Influence on Groundwater Monitoring for the Low-Level Burial Ground Trenches 31 and 34

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

ch2m

P.O. Box 1600
Richland, Washington 99352

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APPROVED
By Julia Raymer at 12:13 pm, Aug 10, 2016

Release Approval Date

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Statement of certification:

I am a licensed Professional Engineer in the State of Washington, No. 41213, with degrees in Chemical and Civil Engineering. I have over 29 years of professional experience in groundwater systems. I reviewed the attached engineering study referenced as “SGW-59564, Rev. 0, Engineering Evaluation of the 200 West Pump and Treat Influence on Groundwater Monitoring for the Low-Level Burial Ground Trenches 31 and 34, CH2M HILL Plateau Remediation Company, Richland, Washington” and I certify that it demonstrates completeness in compliance with WAC 173-303-806(4)(a).

8/1/16

Michael T. Rafferty, P.E. — Date

Vice President and Principal

S.S. Papadopulos & Associates, Inc.

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Terms

CCU	Cold Creek unit
CPGWM	Central Plateau groundwater model
DQO	data quality objective
DWS	drinking water standard
Ecology	Washington State Department of Ecology
gpm	gallons per minute
HDPE	high-density polyethylene
IW	injection well
Kd	distribution coefficient
LLBG	Low-Level Burial Grounds
LLWMA	Low-Level Waste Management Area
MCL	maximum contaminant level
MDL	method detection limit
MRDL	maximum residual disinfectant level
MT3DMS	Modular 3-D Transport Multispecies
OU	operable unit
P&T	pump and treat
RCRA	*Resource Conservation and Recovery Act of 1976*
SALDS	State-Approved Land Disposal Site
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System

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1 Introduction

This engineering report describes the proposed final status groundwater monitoring plan for the Low-Level Burial Grounds (LLBG) Trenches 31 and 34 (inclusive of the Trench 31 and Trench 34 Waste Treatment and Storage Pads) and provides an evaluation of a proposed groundwater monitoring network for detection of groundwater contamination. This study is performed to comply with WAC 173-303-806, "Dangerous Waste Regulations," "Final Facility Permits," which outlines the contents of the Part B permit application pertinent to *Resource Conservation and Recovery Act of 1976* (RCRA) final status groundwater monitoring. WAC 173-303-806(4)(xx)(E) requires the preparation of detailed plans and an engineering report describing the proposed monitoring program to meet the requirements of WAC 173-303-645(8), "Dangerous Waste Regulations," "Releases from Regulated Units," general groundwater monitoring requirements. Specific provisions in the regulation require a groundwater monitoring system consisting of a sufficient number of wells installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer. Furthermore, the samples collected shall represent the quality of background groundwater that has not been affected by leakage from a regulated unit, represent the quality of groundwater passing the point of compliance, and allow for the detection of contamination when dangerous waste constituents have migrated from the waste management area to the uppermost aquifer.

This report is also prepared to address specific information requested in Washington State Department of Ecology (Ecology) Letter 15-NWP-157, "Groundwater Monitoring Requirements for Low-Level Burial Grounds Trenches 31/34 Permit Modification to the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 9, for the Treatment, Storage, and Disposal of Dangerous Waste*." The letter requires the following documentation in this engineering report for LLBG Trenches 31 and 34:

- Information necessary to support the design of the groundwater monitoring well network, such that it is capable of yielding representative samples of groundwater potentially impacted by releases from the two regulated units under the influence of the adjacent 200-ZP-1 Operable Unit (OU) pump and treat (P&T) injection well(s) (IWs)
- Information supporting design of the groundwater monitoring program that is capable of detecting significant increases in groundwater contamination at the earliest practicable time, reflecting the influence of the adjacent IW(s)
- Information describing the approach, input data, any additional information needs, and analysis proposed to evaluate and respond to changes in the groundwater flow regime as it evolves over time under the influence of the adjacent IW(s)

According to WAC 173-303-806 (4)(xx)(E), a detailed plan of monitoring will be specified in a separate groundwater monitoring plan and included in the Part B application with this engineering report. At the discretion of Ecology, implementation of the groundwater monitoring plan may be carried out prior to or after a documented release of contamination from the facilities lined leachate collection system. Evidence of a release should be determined based on sampling and analysis and monitoring of the leachate. A release to the environment has not been documented at the facility to-date.

1.1 Background

Used for the disposal, treatment, and storage of mixed-RCRA waste, LLBG Trenches 31 and 34 are operating dangerous waste management units used for disposal of mixed RCRA wastes. The trenches are located in the 200 West Area Low-Level Waste Management Area 3 (LLWMA-3) on the Hanford Site in Washington State. LLWMA-3 consists of 76 unlined trenches and 2 lined trenches that are managed in 4 LLBGs: 218-W-3A, 218-W-3AE, 218-W-5, and 200-W-254. The area of the 200-W-254 LLBG was originally part of the 218-W-5 Burial Ground. In 2014, a new site code (200-W-254) was identified in the Hanford Site Waste Information Data System (WIDS) database to identify the operating units of the LLBG containing Trenches 31 and 34 (inclusive of the Trench 31 and 34 Waste Treatment and Storage Pads). The location of the Hanford Site, 200 West Area, LLWMA-3, and LLBG Trenches 31 and 34 are shown in Figures 1-1 and 1-2.

LLBG Trenches 31 and 34 were constructed in 1994 with adjacent waste treatment and storage pad. The principal design features of the LLBG trenches include provisions for liquid collection systems using geomembrane trench liners. As such, the lined trenches are RCRA-compliant land disposal units. Each trench was constructed with a double liner and a leachate collection/removal system. The treatment and storage pads direct all surface runoff to the leachate collection system of the lined trenches and are considered separate dangerous waste management units according to DOE/RL-2015-74, *Hanford Facility Dangerous Waste Part B Permit Application; Low-Level Burial Grounds Trenches 31-34-94, T Plant Complex, and Central Waste Complex-Waste Receiving and Processing Facility*. The bottom and sides of each trench are covered with a 0.9 m (3 ft) layer of soil to protect the liner system during fill operations. Additional layers progressing toward the subgrade for each trench includes the following:

- A geotextile that acts as a filter between the operations layer and the primary drainage gravel
- A 0.3 m (1 ft) layer of primary drainage gravel
- A geotextile that serves as a cushion between the drainage gravel and the primary and secondary geomembranes
- A geonet with high transmissivity, which functions as a redundant drainage system in conjunction with the drainage gravel on the floor
- A primary leachate barrier, a 60 mil high-density polyethylene (HDPE) liner
- 0.46 m (1.5 ft) of compacted clay (12 percent)/soil (admix)
- A geotextile cushion
- 0.3 m (1 ft) of drainage gravel 40 A geotextile cushion, geonet, and a secondary 60 mil HDPE liner
- 0.94 m (3.1 ft) of admix material (clay/soil) meeting permeability requirements

On the trench side slopes, the primary and secondary liner systems use geocomposite (two geotextiles thermally bonded to a geonet) drainage layers rather than a drainage gravel and geotextiles used on the floors.

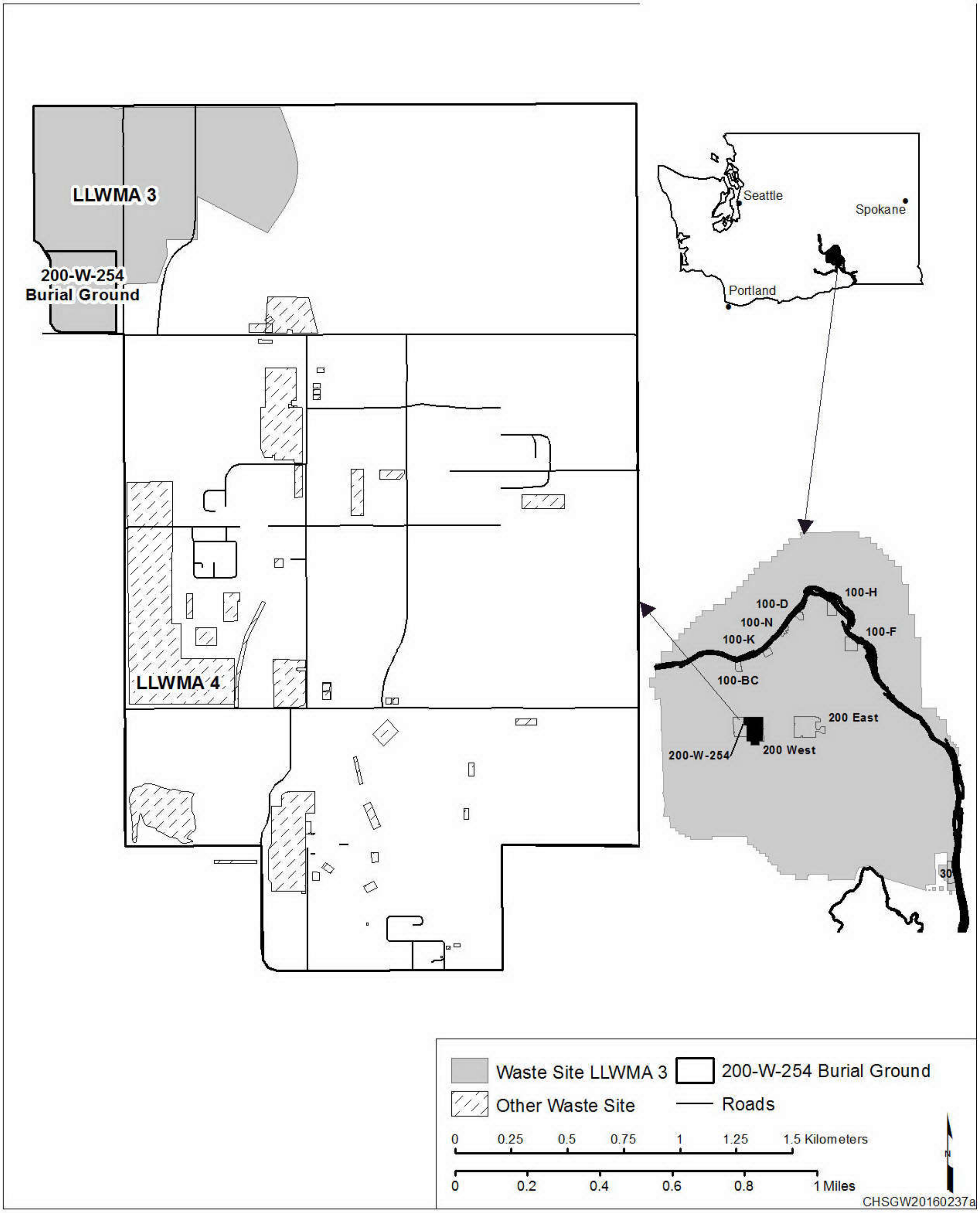


Figure 1-1. Location Map of the Hanford Site, 200 West Area, LLWMA-3, and the 200-W-254 Burial Ground

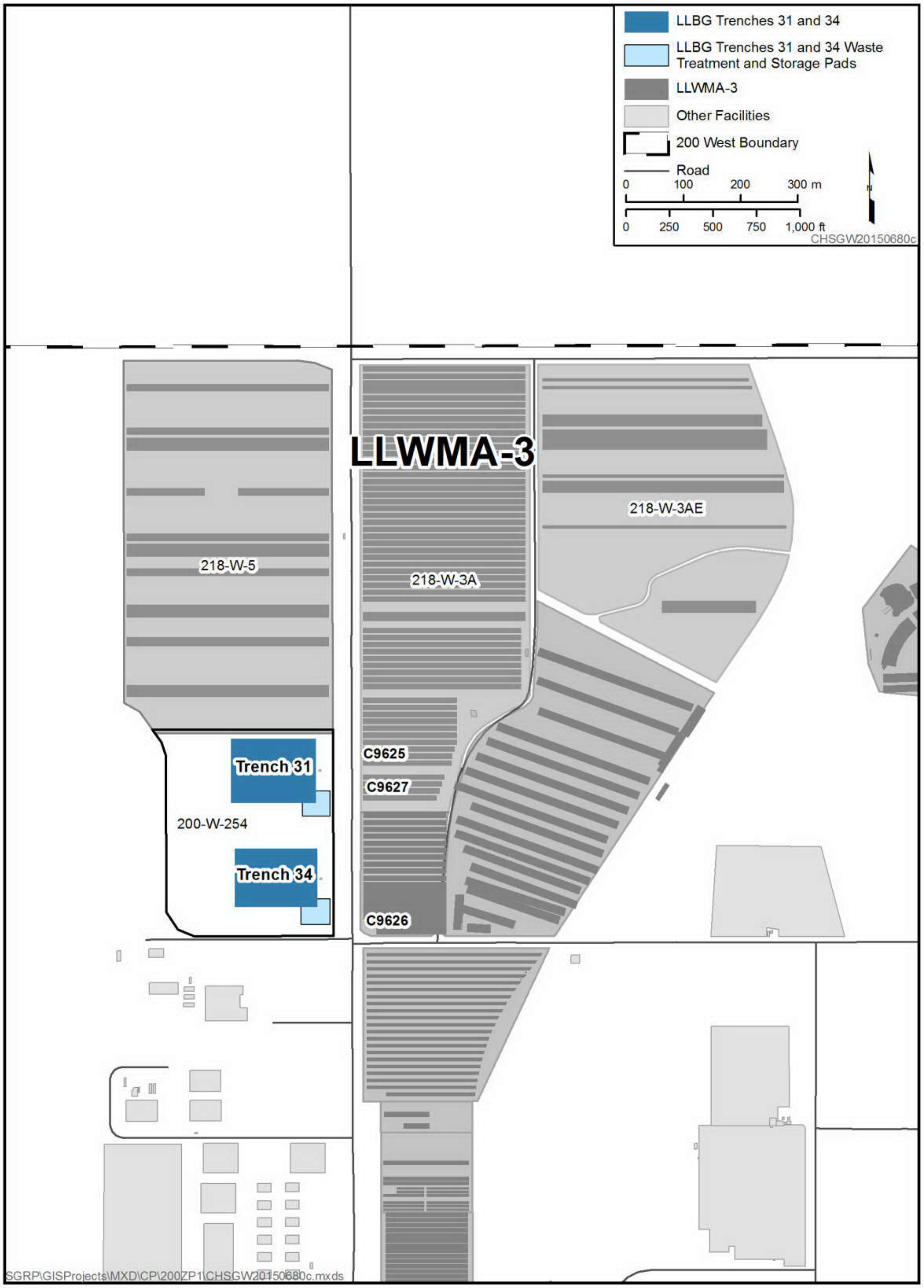


Figure 1-2. Location Map of LLWMA-3, 200-W-254 Burial Ground, and LLBG Trenches 31 and 34

The leachate collection system is capable of collecting and removing leachate such that a nominal hydraulic head on the liner is not exceeded. The primary leachate collection system is composed of 4 in. diameter perforated drainage pipes that lie along the centerline of the floor, at the base of the side slopes, and down the "upslope" side of the access ramp. The floor's slope directs leachate to the center of the floor, which also slopes down toward the sump areas located at the east ends of both trenches. The secondary leachate collection system is installed above the secondary liner system. Pumps are provided in both the primary and secondary sump areas. Collected leachate is pumped into WAC 173-303-compliant, 37,800 L (10,000 gal) accumulation tanks. The system was designed with consideration for the 24-hour peak precipitation event (3.96 cm [1.56 in.]) over a 25-year period. To date, there has not been a release (e.g., leakage) from LLBG Trenches 31 and 34.

The approximate base dimensions of each trench area are 76.2 m by 30.5 m (250 ft by 100 ft), with a surface grade footprint of 1.3 ha (3.21 ac). The trenches are designed for approximately 21,000 m^3 (27,000 yd^3) of mixed waste. The floor of both trenches slopes slightly, providing a variable depth of 9.1 to 12.2 m (30 to 40 ft). The floor slope is a minimum of 2 percent, draining to a recessed area at the eastern end that houses the sump for leachate collection. The side slope ratio is 3:1 (horizontal to vertical). Access to the trench floor is provided by a ramp with an 8 percent slope.

LLBG Trenches 31 and 34 are designed for disposal of miscellaneous dry wastes from various operations at the Hanford Site and from offsite facilities. LLBG Trenches 31 and 34 began receiving low-level mixed dry waste in 1999. Mixed waste disposed in the LLBG trenches include bulk wastes, containerized wastes, inherently stable waste, and long-length contaminated equipment. A diverse range of waste containers can be disposed at LLBG Trenches 31 and 34 including, but not limited to, containers/drums, waste boxes, and miscellaneous equipment. LLBG Trench 34 is also designed for receipt and final disposal of decommissioned, defueled nuclear reactor compartments.

All mixed waste destined for disposal in LLBG Trenches 31 and 34 meets land disposal requirements (WAC 173-303-140, "Dangerous Waste Regulations," "Land Disposal Restrictions," which includes, by reference, 40 CFR 268, "Land Disposal Restrictions") and 69 FR 39449, "Record of Decision for the Solid Waste Program, Hanford Site, Richland WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant." A site-specific treatability variance approved by Ecology must be obtained for waste not meeting these requirements. The pads provide greater than 90-day treatment and storage for mixed waste prior to waste placement into the trenches for disposal.

At the time of closure, a final cover will be constructed over the facility to minimize infiltration.

1.2 Interim Status and Proposed Final Status Groundwater Monitoring

The interim status groundwater monitoring network for LLBG Trenches 31 and 34 currently consists of wells 299-W-9-2, 299-W10-29, 299-W10-30, and 299-W10-31. Interim status groundwater monitoring requirements for LLBG Trenches 31 and 34 are documented in DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3.* The interim status network is a result of previous investigations and data quality objective (DQO) equivalent studies. Table 2-1 in DOE/RL-2009-68 provides a matrix of data requirements that are typically determined using the DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program complies with the requirements.

The DQO process for the trenches (SGW-47729-VA, *Low-Level Burial Ground 3 Trenches 31 and 34 DQO Process*) included modeling to evaluate the effects of the 200 West P&T at the monitoring well locations.

The proposed LLBG Trenches 31 and 34 final status groundwater monitoring plan detailed in this report consists of one upgradient (299-W9-2) and five downgradient wells (299-W10-29, 299-W10-30, C9625, C9626, C9627). The upgradient well (299-W9-2) and downgradient wells 299-W10-29 and 299-W10-30 are in the current interim status groundwater monitoring network. Three additional downgradient wells (C9625, C9626, and C9627) are proposed for final status monitoring based on the simulation presented in this document. Under final status requirements, the proposed indicator parameter dangerous waste constituents include arsenic, cadmium, mercury, benzene, 1,1,1-trichloroethane, 4-methyl-2-pentanone, and dichloromethane for statistical evaluation for significant increases in groundwater concentrations. Samples will also be collected and analyzed for alkalinity, anions, and metals to assess groundwater quality. Water-level measurements shall also be collected each time a well is sampled. The six groundwater wells proposed for LLBG Trenches 31 and 34 final status groundwater monitoring are shown in Figure 1-3. Figure 1-4 is a location map for all the wells discussed in this report. The final status groundwater monitoring plan for the LLBG Trenches 31 and 34 shall supersede the interim status previous plan (DOE/RL-2009-68) when issued.

1.3 Report Organization

The report is organized as follows:

- Chapter 2 describes the geology and hydrogeology of LLBG Trenches 31 and 34.
- Chapter 3 identifies waste constituents of interest.
- Chapter 4 describes the groundwater simulations conducted to evaluate the monitoring network for releases from Trenches 31 and 34 and influence of the 200 West P&T.
- Chapter 5 describes calibration of the groundwater model used to perform the simulations.
- Chapter 6 discusses the results of the simulations.
- Chapter 7 describes the proposed final status groundwater monitoring plan.
- Chapter 8 lists the references cited in this report.

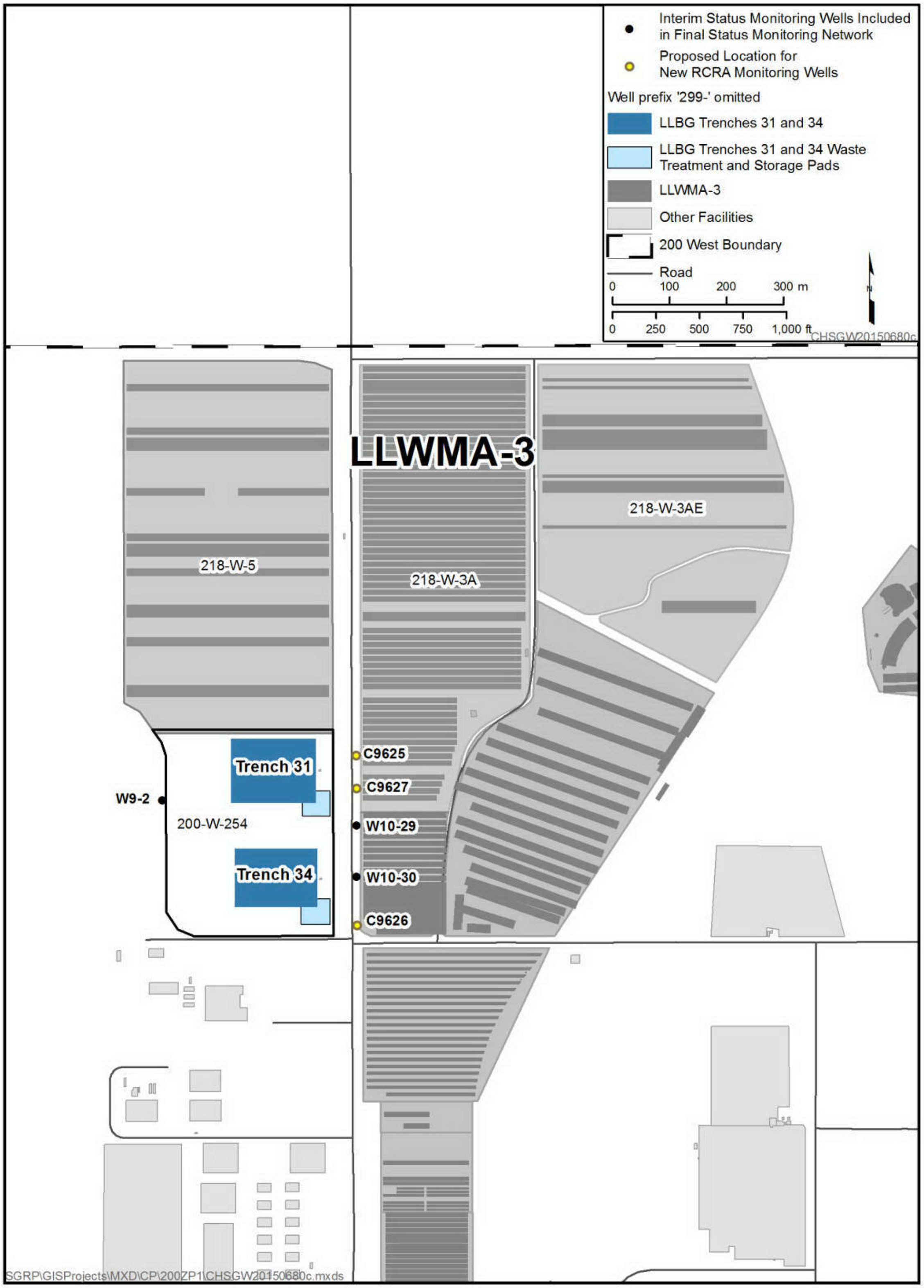


Figure 1-3. Proposed Final Status Groundwater Monitoring Network for LLBG Trenches 31 and 34

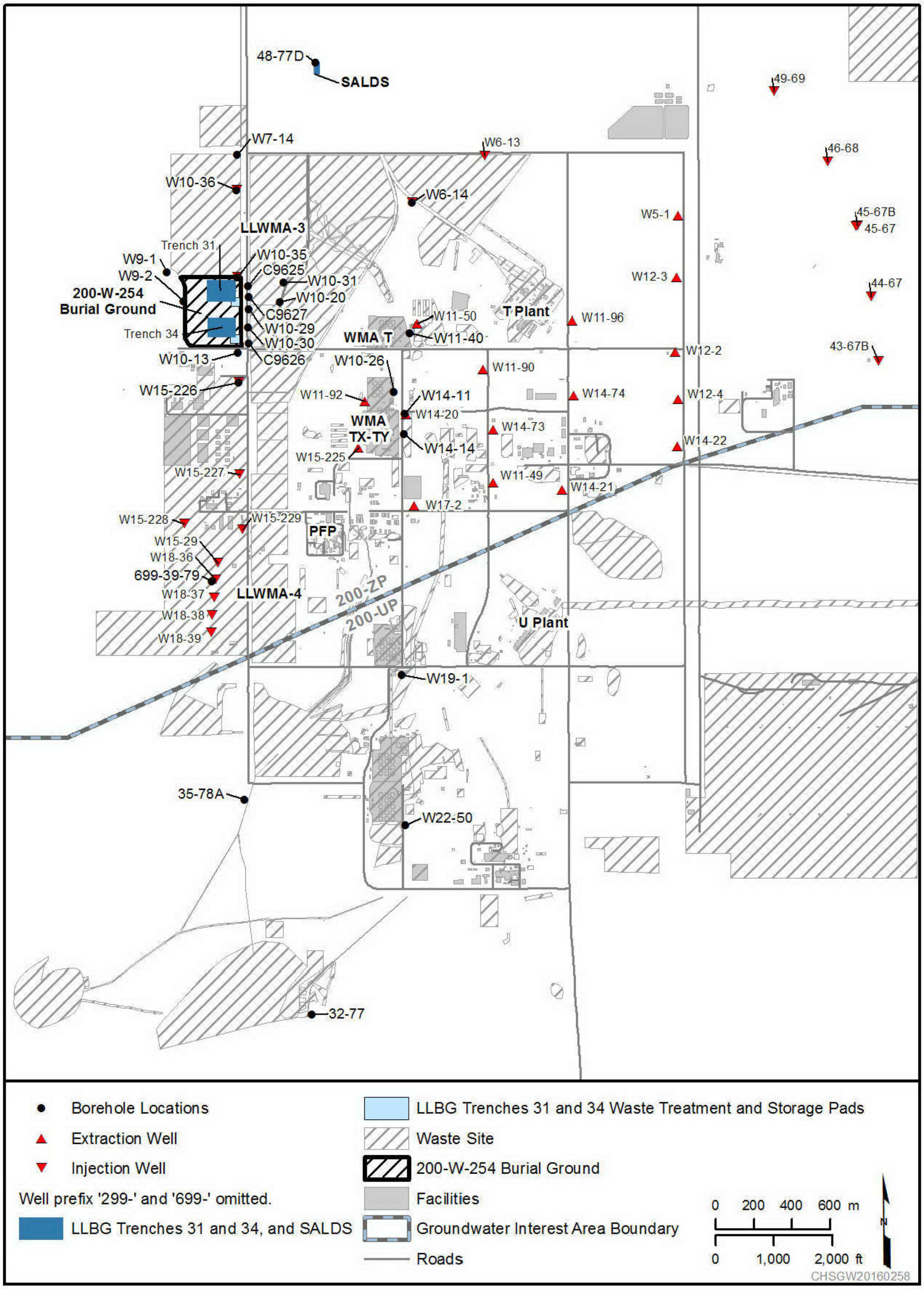


Figure 1-4. 200 West Borehole Location Map

2 Geology and Hydrogeology

The geology and hydrogeology of the 200 West Area, including the area of LLBG Trenches 31 and 34, are described in the following documents:

- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds–An Interim Report*
- PNL-7336, *Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site*
- PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*
- PNNL-16887, *Geologic Descriptions for the Solid-Waste Low Level Burial Grounds*
- WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*
- WHC-SD-EN-TI-290, *Geologic Setting of the Low Level Burial Grounds*

The following discussions in this chapter are based mainly on these documents. A stratigraphic column and geologic cross section for LLBG Trenches 31 and 34 are presented in Figures 2-1 and 2-2.

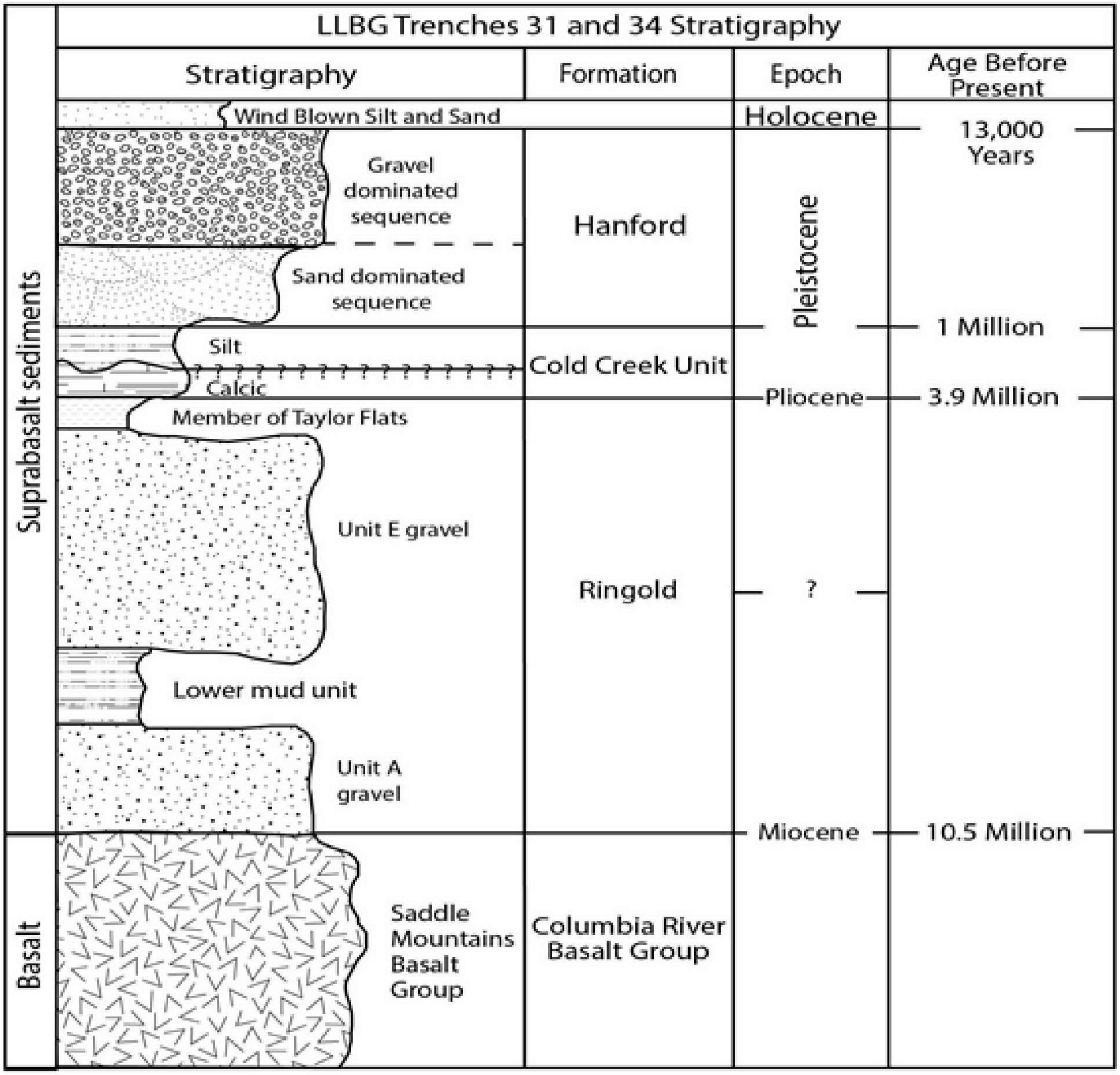
2.1 Stratigraphy

In descending order, Holocene surficial deposits and sediments of the Hanford formation, the Cold Creek unit (CCU), and the Ringold Formation are present at LLBG Trenches 31 and 34. These suprabasalt sediments overlie the Saddle Mountains basalt of the Columbia River Basalt Group.

Surficial deposits at the trenches consist of Holocene eolian sand to silty sand. These windblown soils are not continuous across the site and are up to several feet thick.

Basalt-rich glaciofluvial unconsolidated gravel and sand of the Hanford formation are present at the surface where surficial deposits are absent at the site. These sediments were deposited by Pleistocene cataclysmic floodwaters 13,000 years to 1 million years before present. The gravel-dominated sequence consists of uncemented, matrix-poor, cross-stratified, coarse-grained sands and granule to boulder size gravel. The sand-dominated sequence consists of well-stratified fine to coarse sand with less gravel. Silt in these lithologies is variable. A silt-dominated sequence is also associated with the Hanford formation and does not appear to the present beneath trenches. The Hanford formation is 26 m (85 ft) to 40 m (131 ft) thick and thins to the north beneath the trenches. Soft sediment deformation (i.e., clastic dikes) are common features within the Hanford formation.

The CCU, formally known as the Plio-Pleistocene Unit/Early Palouse Soil, underlies the Hanford formation beneath the trenches. This unit was deposited 1 to 3.9 million years before present. The CCU consists of very hard rock that formed during soil development as precipitation evaporated and left behind minerals forming caliche called hardpan. This unit may also consist of wind-blown unconsolidated muddy fine sand to fine sandy mud. In the 200 West Area, the CCU is 0 to 20 m (0 to 66 ft) thick. Beneath the trenches, the CCU is about 8 m (26 ft thick) and dips to the south.



Not to Scale

Figure 2-1. Stratigraphic Column for LLBG Trenches 31 and 34

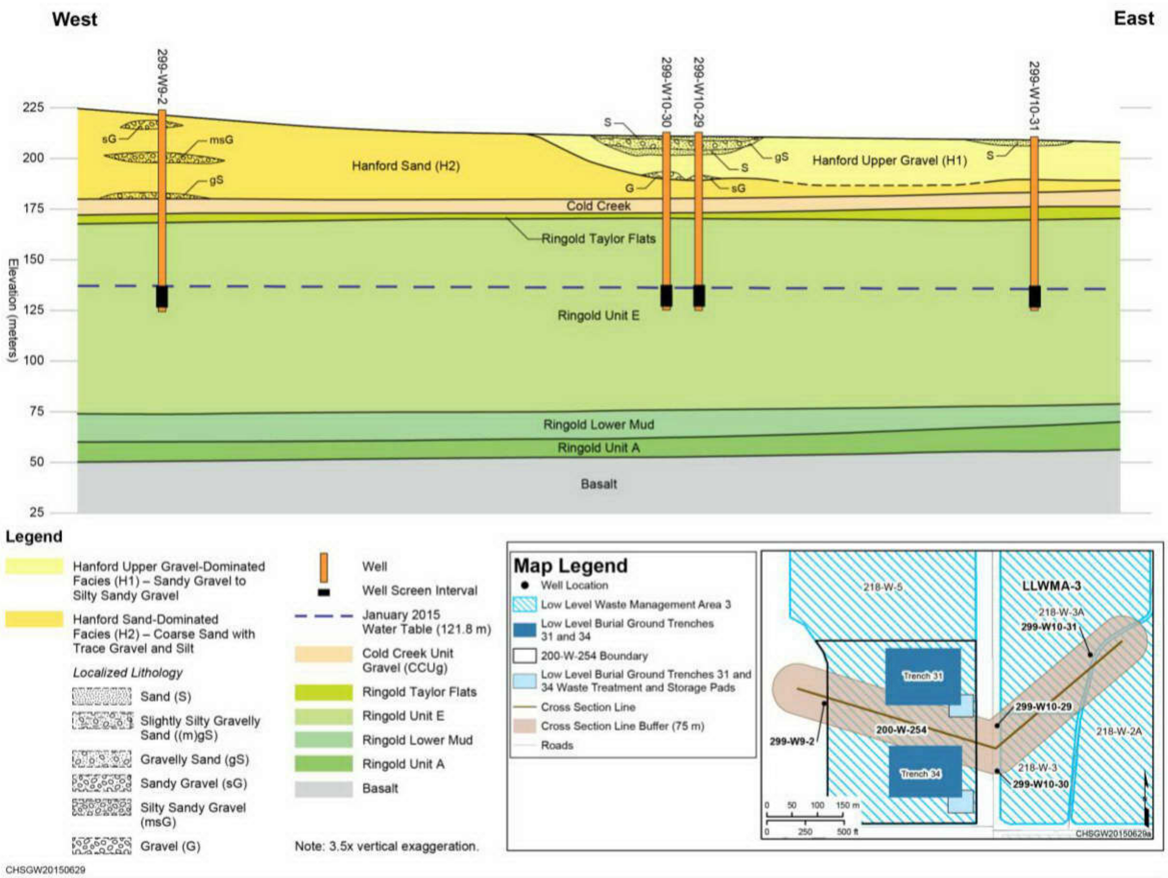


Figure 2-2. Geologic Cross Section Through LLBG Trenches 31 and 34

The Ringold Formation underlies the CCU and overlies basalt beneath the trenches. This formation consists of fluvial-lacustrine sediments deposited by the ancestral Columbia River about 3.9 to 10.5 million years before present. These semi-consolidated sediments consist of an intercalated mix of gravel, sand, and silts to silt-rich paleosols and lake deposits. Beneath the trenches, the Ringold Formation is subdivided into the four units in descending order: Member of Taylor Flat (upper Ringold), Unit E, the Ringold lower mud, and Unit A. The Ringold Formation is up to 122 m (400 ft) thick beneath the trenches and dips to the south. A brief description of each unit is provided below.

- The Ringold Formation member of Taylor Flat consists of an abundance of well-sorted sand to muddy sand and gravelly sand. Deposition of this unit represents transition to a lower energy fluvial environment compared to Unit E. Beneath the trenches, this unit is about 4 m (13 ft) to 7 m (23 ft) and thins to the south.
- Ringold Formation Unit E makes up over 75 percent of the Ringold Formation and intersects the water table surface at an elevation of about 136 m (446 ft). Unit E consists mostly of coarse-grained gravel and sand deposited in a high-energy fluvial environment. This unit is about 92 m (302 ft) to 94 m (308 ft) thick near the trenches.
- The Ringold Formation lower mud unit represents the base of the unconfined aquifer beneath the trenches. This unit consists predominantly of silt with approximately equal amounts of sand and clay. Beneath the trenches this unit is about 9 m (30 ft) to 13 m (42 ft) thick and thins to north where it pinches out north of the 200 West Area fence boundary and northeast of the trenches.

- Ringold Formation Unit A is similar in texture to Ringold Formation Unit E. Where the Ringold formation lower mud is not present it is difficult to differentiate between Unit E. Beneath the trenches this unit is about 11 m (36 ft) to 13 m (43 ft) thick and directly overlies basalt of the Elephant Mountain Member.
- The Saddle Mountain Basalt is the uppermost formation of the Columbia River Basalt Group beneath the trenches. The uppermost basalt unit is Elephant Mountain Member dated about 10.5 million years before present. The surface of the basalt slopes gently to the south at an elevation of 50 m (164 ft) to 56 m (184 ft).

2.2 Hydrogeology

2.2.1 Aquifer Recharge

Natural recharge to the Hanford Sites unconfined aquifer is from precipitation ([~18 cm/yr. [~7 in/yr]) and runoff from Rattlesnake and Yakima ridges. The ridges are located south and west of the 200 Areas and expressed at the surface as long linear outcrops at an elevation of 1,060 m (3,527 ft). Recharge to the aquifer near the LLBG trenches is mainly from artificial and, possible natural sources. Any natural recharge originates from precipitation. Estimates of recharge from precipitation range from 0 to 10 cm/yr. (0 to 4 in./yr) and are largely dependent on the soil texture and the type and density of vegetation. Directly beneath the LLBG trenches natural recharge to the aquifer may not occur because of the lined leachate collection system. Liquids are routinely sampled and pumped from the leachate collection system.

Artificial recharge to the aquifer near the LLBG trenches occurred when effluent was discharged to the ground and by the injection of treated groundwater from the 200 West P&T remedy. After the start-up of Hanford site operations in 1944, water levels in the unconfined aquifer increased as much as 13 m (43 ft) above the pre Hanford natural water table. Hydrographs from selected wells show changes in the elevation of the water table in the 200 West Area (Figure 2-3). Discharges to the T Pond (1944 to 1976), and U Pond (1944-1985) systems and other liquid waste receiving sites were the cause of water table elevation changes and changes in groundwater flow direction. The impact of artificial recharge on groundwater flow direction is discussed in Section 2.3

Most discharges of effluent to the ground in the 200 Area ceased in the mid-1990s. The only current permitted discharge to the ground in the 200 West Area is from a State-Approved Land Disposal Site (SALDS). The SALDS is located about 1200 m (4000 ft) northeast of the trenches and began operation in 1995. Since 1995, more than 880 million L (232 million gal) of effluent have been discharged to the facility. Discharges from the approved land disposal site does not appear to significantly impact the groundwater at LLBG Trenches 31 and 34. However, the discharges contributes to the collective groundwater regime in the northern portion of the 200 West Area. Hydrographs from well 699-48-77D (located near the permitted facility) and wells 299-W9-1 and 299-W10-13 (located closer to the LLBG trenches) show that groundwater has been generally declining since SALDS began operations in 1995 (Figure 2-4). Significant impact, in terms of a rise in the elevation of the water table, is not observed after operations began at the SALDS in these wells. Groundwater flow direction at the SALDS is to the northeast away from the LLBG trenches.

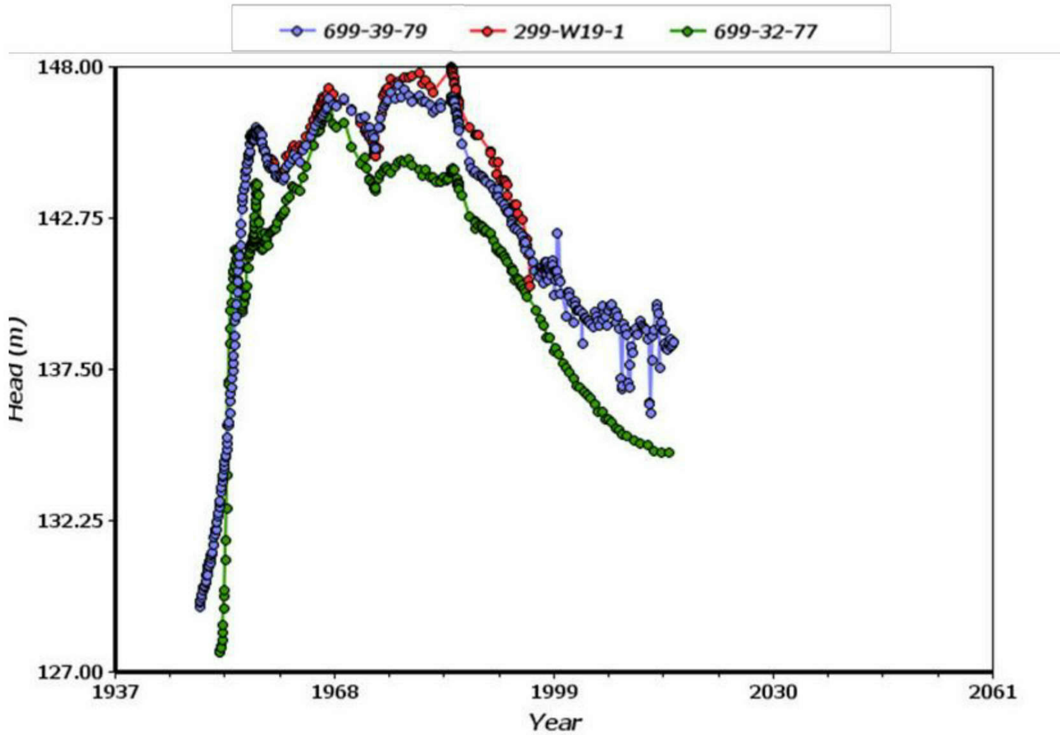


Figure 2-3. Hydrograph from Selected Wells in the 200 West Area

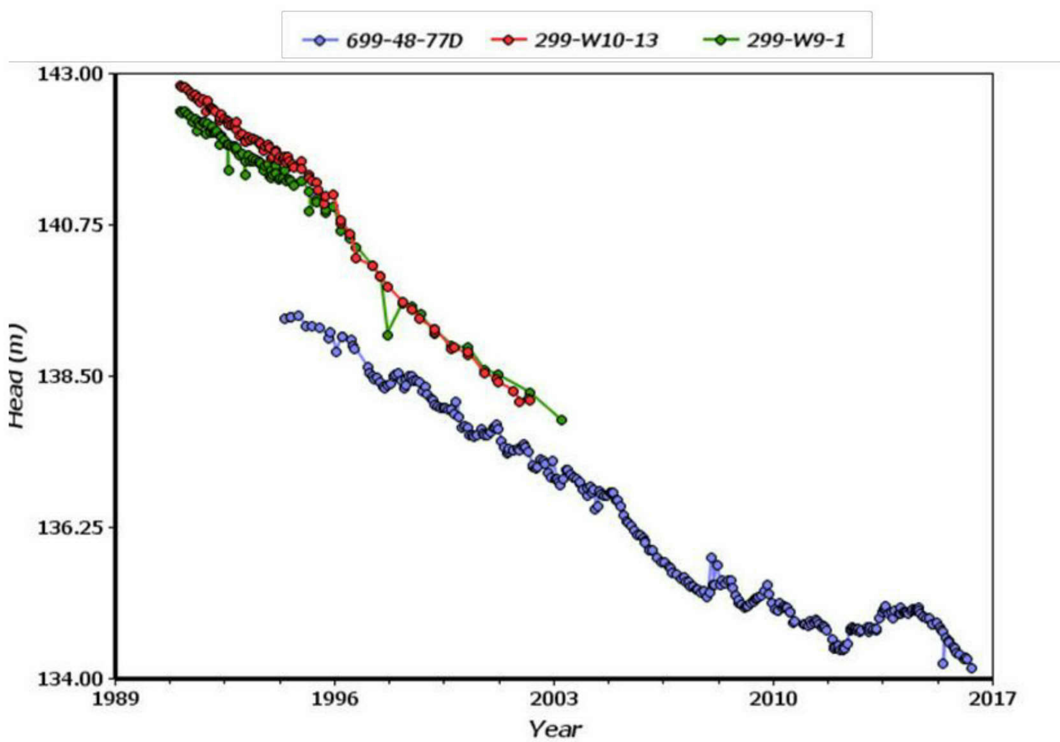


Figure 2-4. Hydrographs from Wells Near of the State-Approved Land Disposal Site and LLBG Trenches

An additional source of artificial recharge to the unconfined aquifer is the 200 West P&T system, which came online in 2012. The system is designed to capture and treat contaminated groundwater. Following treatment, water is reinjected into the aquifer to serve as a recharge source and promote flow path control. According to DOE/RL-2009-124, *200 West Pump and Treat Operations and Maintenance Plan*, the facility can treat up to 9,464 L/min (2,500 gallons per minute [gpm]). With modifications to the system, the treatment capacity can be increased to 14,194 L/min (3,750 gpm) if required.

Although the elevation of the water table has generally been declining (0.4 m [1.4 ft]) in the 200 West Area since the 1980s, the 200 West P&T has raised the elevation of the water table near the trenches about 2 m (6.6 ft). Hydrographs from three LLBG network wells (299-W9-2, 299-W10-29, 299-W10-30) show the impact of the P&T remedy (Figure 2-5). The elevation of the water table across the 200 West Area remains above year 1944 levels. Following the completion of the P&T remedy, groundwater elevation levels are expected to decline near the trenches.

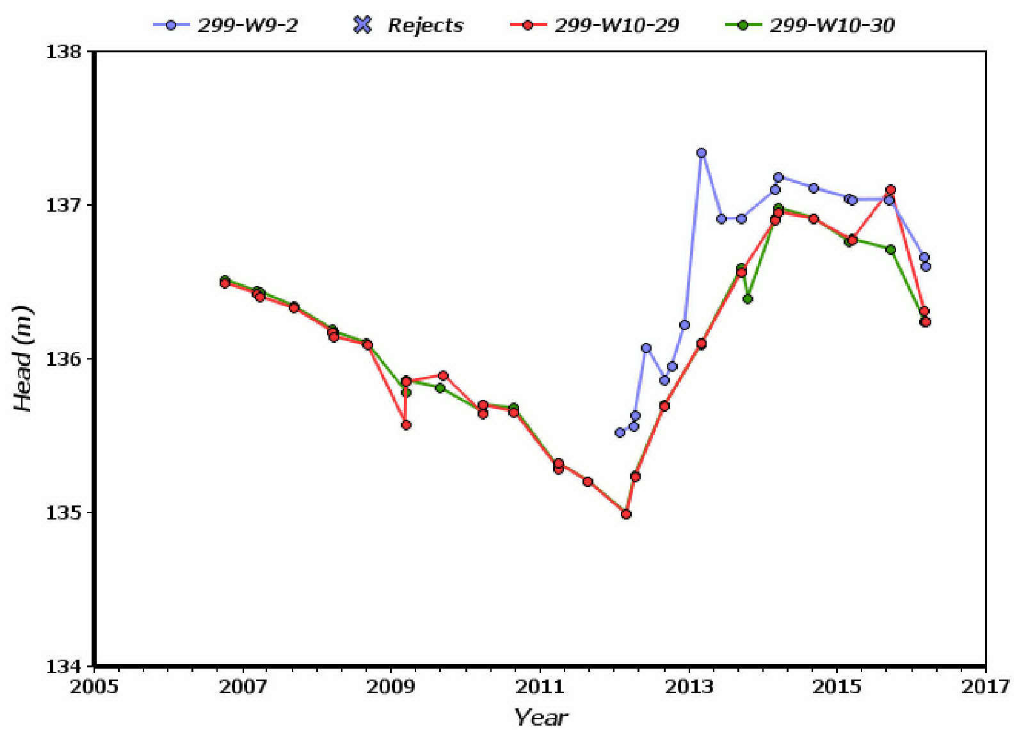


Figure 2-5. LLBG Hydrographs - Impacts to Groundwater from P&T Remedy in 2012

2.2.2 Hydrogeologic Units

Hydrogeologic units near the LLBG trenches are Holocene surficial deposits, the Hanford formation, the CCU, the Ringold Formation (member of Taylor Flats, Unit E, Ringold Lower Mud Unit, Unit A), and basalt of the Elephant Mountain Member. The Hanford formation, the CCU, and Ringold Formation member of Taylor Flats occur entirely in the unsaturated zone (i.e., vadose zone), while the Ringold Formation Unit E is partially within the vadose zone and partially within the unconfined aquifer (i.e., saturated zone). Based on the maximum surface elevations near the top of the trenches, the unsaturated thickness of the vadose zone around LLBG Trenches 31 and 34 is approximately 74 to 78 m (240 to 260 ft). Within the open areas of the trenches, which have been excavated to a depth of 9.1 m (30 ft), the unsaturated thickness of the vadose zone is about 67 m (219 ft).

Ringold Unit E intersects the water table (i.e., unconfined aquifer) at an elevation of 136 m (446 ft). The saturated thickness of the unconfined aquifer is 59 m (194 ft) to 63 m (207 ft). The Ringold Lower Mud Unit underlies Unit E and is the base of the unconfined aquifer. It separates the unconfined aquifer from the confined aquifer that resides within Unit A. The saturated thickness of Unit A is about 9 m (30 ft) to 13 m (42 ft) beneath the trench. Unit A thins to north where it pinches out north of the 200 West Area fence boundary. The uppermost surface of the Elephant Mountain Member (basalt) is considered the base of the suprabasalt aquifer system (bedrock). Saturated hydraulic conductivities for the major sedimentary hydrogeologic units and basalt are shown in Table 2-1. The data in Table 2-1 indicate that the Hanford formation is highly permeable compared to the Ringold Formation. Soil properties of the CCU indicate that this horizon will likely slow the rate of downward movement and promote lateral spreading in the vadose zone. The Ringold lower mud and basalt are considered aquitards relative to other sediments beneath the LLBG trenches because of the unit's very low hydraulic conductivities.

Table 2-1. Hydraulic Conductivities for Major Hydrogeologic Units

Hydrogeologic Unit	Estimated Range of Saturated Hydraulic Conductivities (m/day)	Reference(s)*
Hanford formation	1 to 1,000,000	PNL-8337; PNL-10886; PNNL-11801; PNNL-13858
Ringold Formation Unit E	0.1 to 200	PNL-8337; PNL-10886; PNNL-11801; PNNL-13858
Cold Creek unit	0.0006 to 2.2	WHC-EP-0698
Ringold Formation Lower Mud Unit	0.0003 to 0.09	PNL-8337; PNL-10886; PNNL-11801; PNNL-13858
Ringold Formation Unit A	0.1 to 200	PNL-8337; PNL-10886; PNNL-11801; PNNL-13858
Elephant Mountain Member	0.009	WHC-EP-0698

* Complete reference citations are provided in Chapter 8.

2.3 Groundwater Flow Interpretation

Pre-Hanford Site groundwater flow direction was toward the east in the 200 West Area (BNWL-B-360, S*elected Water Table Contour Maps and Well Hydrographs for the Hanford Reservation, 1944-1973*). After the startup of Hanford Site operations in 1944, the water table beneath the 200 West Area and LLBG Trenches 31 and 34 was affected by disposal of liquid effluent to various facilities. As stated previously, discharges to liquid waste receiving sites that reached groundwater caused changes in the elevation of the water table and changes in groundwater flow direction. Radial groundwater flow was documented in the 200 West Area from 1948 to 1955. In 1955 groundwater flow in the area of the LLBG trenches was to the west and north from a groundwater mound (Figure 2-6). After year 2000, groundwater flow direction was predominantly eastward; however, the elevation of the water table remains elevated. The Hanford Site water table maps from years 2000 and 2005 are shown in PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000,* and PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2006.*

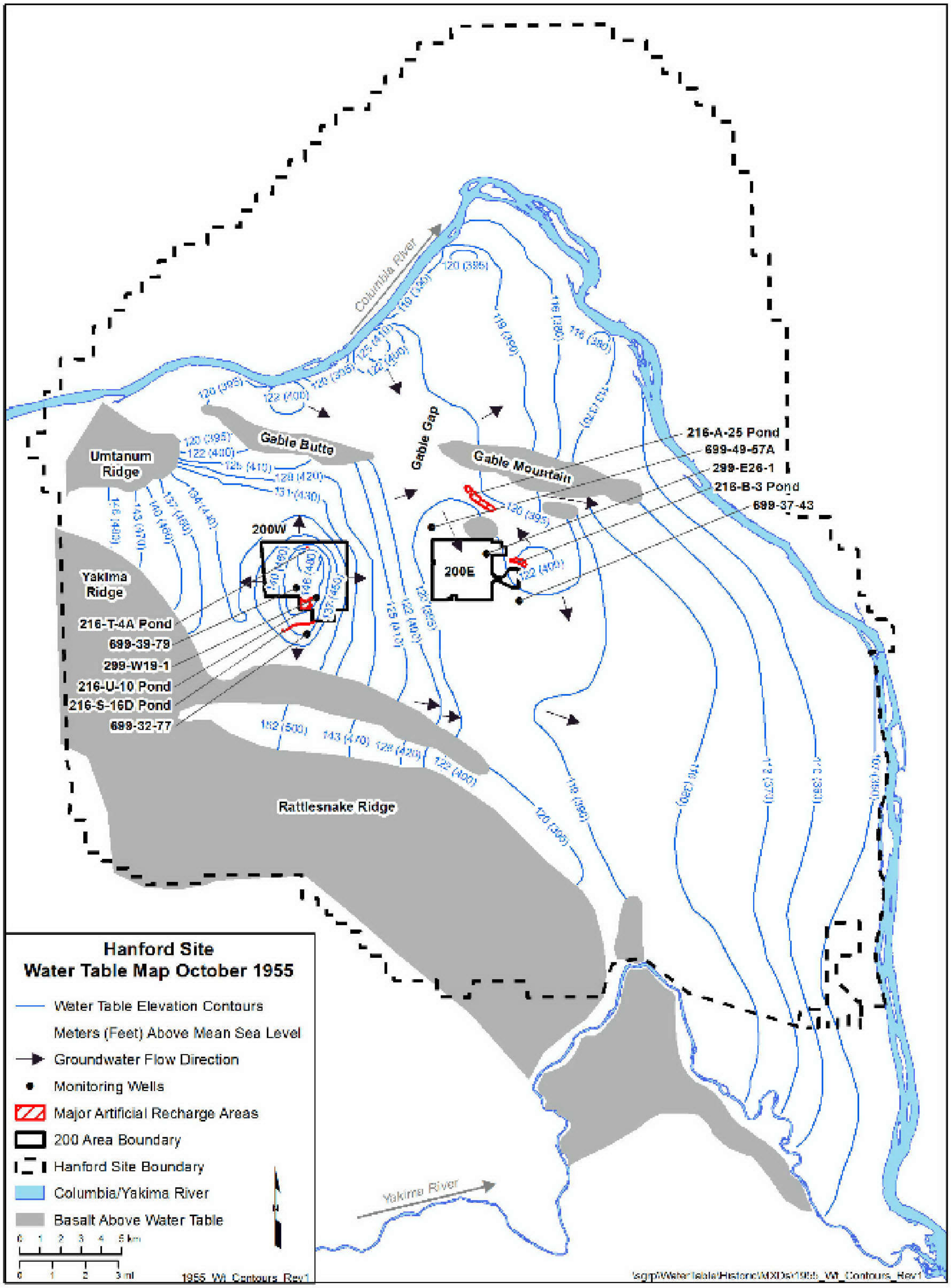


Figure 2-6. 1955 Hanford Site Water Table Map (modified from BNWL-B-360)

2.3.1 2015 Water Table Map

The 2015 Hanford Site water table map shows groundwater flow direction to the east-southeast beneath the LLBG Trenches 31 and 34 (Figure 2-7). Groundwater flow is affected by the 200 West P&T remedy, which began operating in 2012. The system extracts and treats contaminated groundwater. Treated groundwater is injected back into the aquifer in a series of injection wells and has raised the elevation of the water as much as 2 m (6.6 ft) near the trenches. Two injection wells (299-W10-35 and 299-W10-36) are located near the trenches. Another injection well (299-W6-14) is located east of the LLBG Trenches 31 and 34. Injection and extraction wells are shown on the 2015 water table map (Figure 2-7). The hydraulic gradient beneath LLBG Trenches 31 and 34 is estimated to be 7.3 × 10^{-3} m/m based on the 2015 water table map, with an average linear velocity of 0.18 to 0.73 m/day (0.59 to 0.2.4 ft/day) (DOE/RL-2016-12, *Hanford Site RCRA Groundwater Monitoring Report for 2015*).

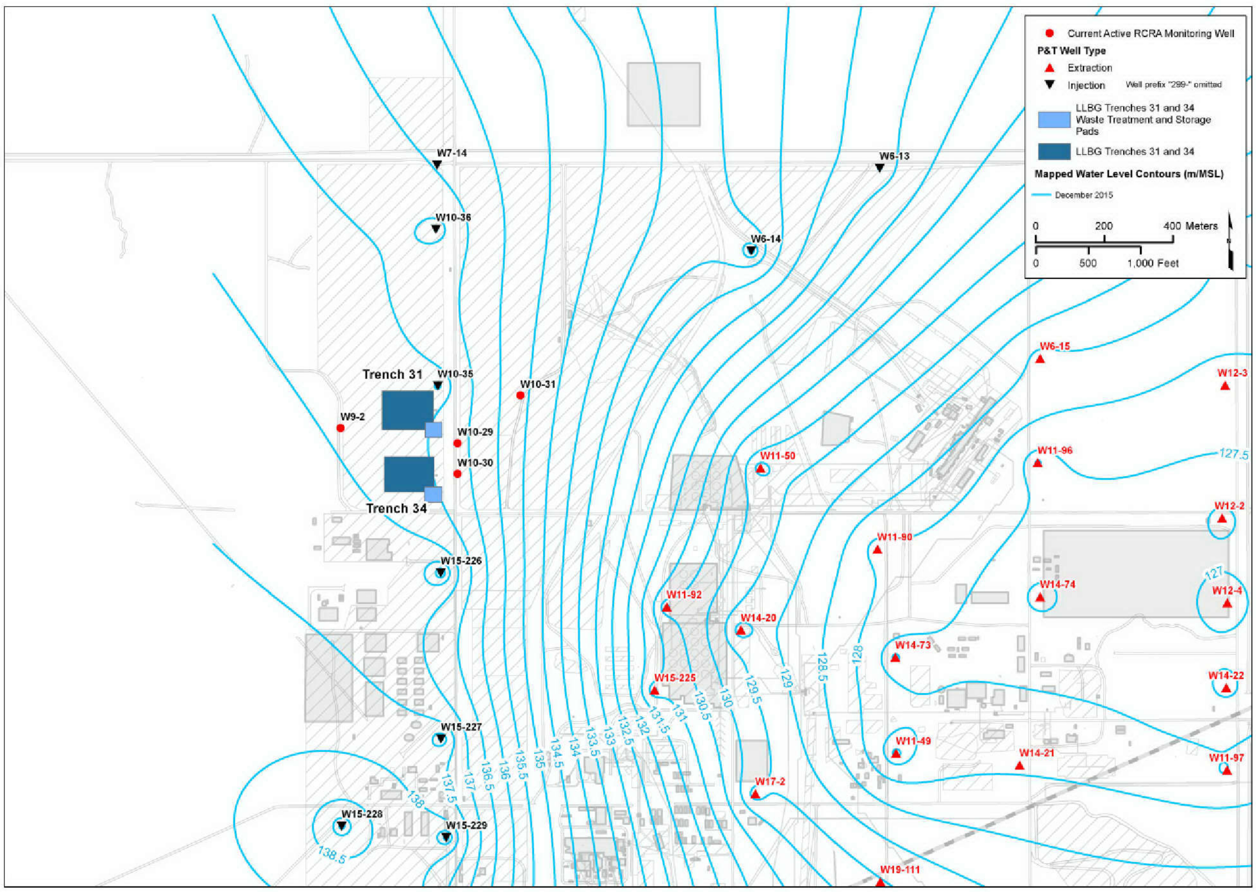


Figure 2-7. 2015 Water Table Map for LLWMA-3 and LLBG Trenches 31 and 34

2.3.2 2012 Water Table Map - Baseline Conditions with No Operating P&T Remedy

Baseline groundwater levels were evaluated in two dimensions by interpolating water-level data obtained during June 2012, at which time no groundwater remedy was operating. Figure 2-8 shows the 2012 water table map prior to the start of the P&T remedy. During this time, groundwater flow direction was to the east-northeast. The hydraulic gradient is estimated to be 1.5 × 10^{-3} m/m in 2012 with an average linear velocity of 0.04 to 0.15 m/day (0.13 to 0.49 ft/day) (SGW-55438, *Hanford Site Groundwater Monitoring for 2012: Supporting Information*).

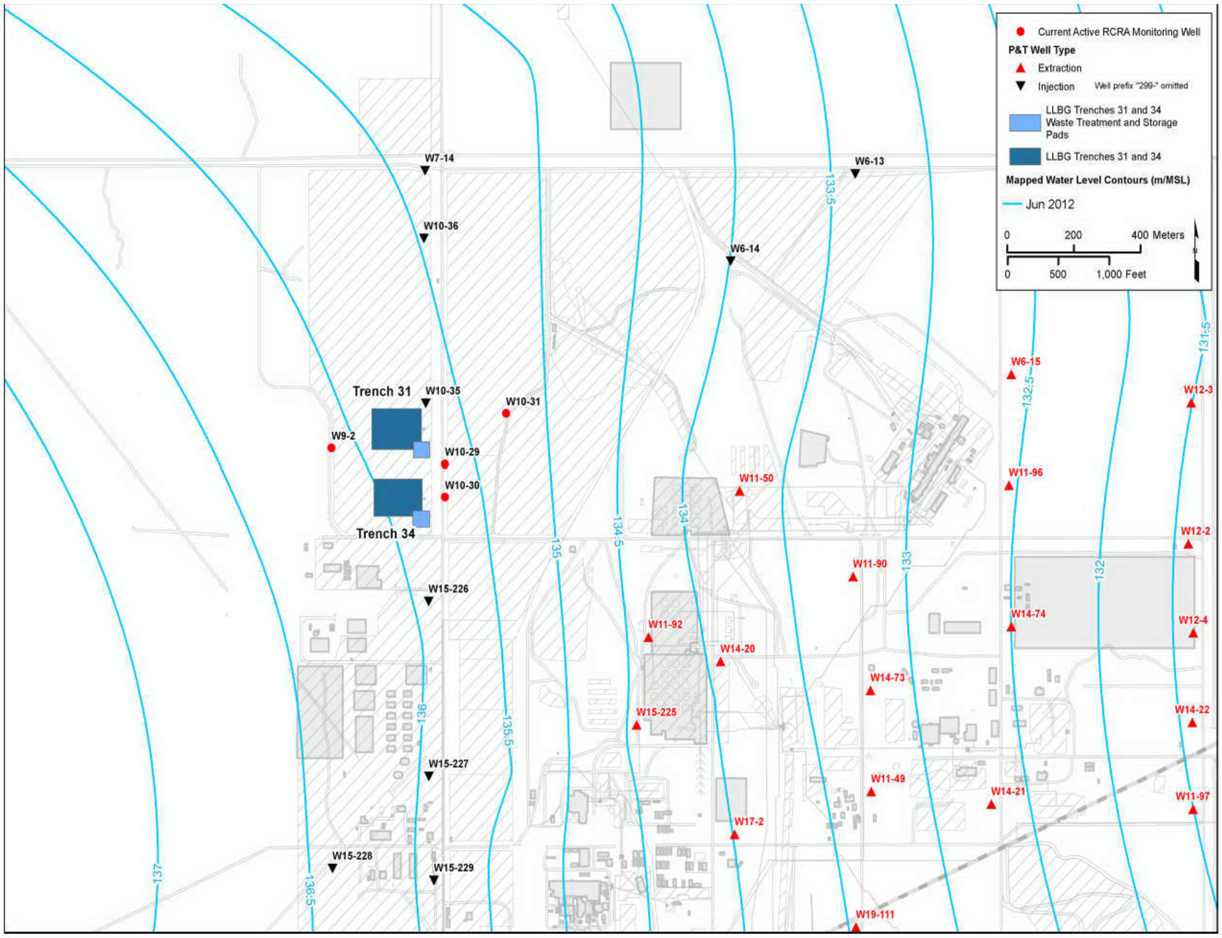


Figure 2-8. Water Elevation Contours in June 2012 Prior to Startup of the 200 West P&T

3 Site-Specific Waste Constituents

LLBG Trenches 31 and 34 have not been identified as a source to groundwater contamination and are currently monitored for indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides) as identified in DOE/RL-2009-68. This chapter identifies specific waste constituents that will be included in the detection monitoring program (WAC 173-303-645(9), "Dangerous Waste Regulations" "Releases from Regulated Units") for Trenches 31 and 34.

3.1 Conceptual Site Model

The conceptual site model for contaminant release and transport is based on the following assumptions:

- Average precipitation and net infiltration (5 to 10 cm/yr [2 to 4 in./yr]) prevail over the timeframe of interest (operational lifespan and post-closure monitoring period).
- Net infiltration is assumed to occur under gravity drainage on the trench floor and slopes into the leachate collection system.
- Leaching of mobile contaminants from buried waste in damaged/degraded sealed containers or contaminated soils in direct contact with the trench is assumed the major potential source for contamination to enter the leachate sumps.
- Contaminated leachate leaking from the sumps or damaged/degrading liners is the major potential source for contamination to enter the vadose zone beneath the trenches.
- Maximum vertical hydraulic conductivity in the vadose zone under the secondary liner system is assumed significantly larger than the net infiltration rate.
- Artificial sources of water (e.g., leaking potable or raw water lines) are not present based on Hanford Site drawings.
- Extreme conditions or accidental releases are recognized as factors but would be addressed under emergency response/corrective actions.

3.1.1 Vadose Zone

The vadose zone beneath LLBG Trenches 31 and 34 is approximately 75 m (246 ft) thick and consists of (from top to bottom) the Hanford formation, the CCU, and the Ringold Formation. The CCU is likely to slow downward movement of moisture and contaminants because of the finer textured sediment and cementing that characterize this stratigraphic feature in the vadose zone.

Based on the trench construction details, the volume of the pore space beneath both of the trenches to the water table is approximately 87,100 m^3 (2.30E+07 gal), assuming 25 percent effective porosity in the vadose zone sediment; 4,650 m^2 (50,000 ft^2) for the area of the mixed waste trenches; and 75 m (246 ft) to the water table. Historical knowledge of past leaks or releases into the vadose zone from analogous sites indicates that the leaks would not cover the entire surface area prior to infiltration. Leakage from the waste in the trenches would tend to collect in the low sump area, which is approximately 10 to 15 percent of available surface area under the trenches that may become saturated with liquid waste. Using 15 percent to be conservative, the available volume of pore space is 13,070 m^3 (3,450,000 gal).

The leachate collection system for both trenches (primary and secondary sumps), when full, has a total capacity of 2,100 m^3 (555,000 gal), assuming a conservative 75 percent effective porosity. Using this capacity volume, the ratio of pore space in the vadose zone between the trench and water table to leachate collection capacity is calculated as approximately 6:1; therefore, available pore space volume is over six times greater than the volume of a catastrophic release. The large calculated spare capacity would likely impede migration of liquid waste to groundwater.

Additionally, a finer grained lithologic unit lies below the CCU within the stratigraphic framework under LLBG Trenches 31 and 34. The Taylor Flat member of the Ringold Formation (shown in Figures 2-1 and 2-2) is interpreted from well construction geologic logs near LLBG Trenches 31 and 34. It is a fine-grained sequence consisting of interstratified, well-bedded, fine to coarse sand to silt and is equivalent to the upper Ringold Formation unit mentioned in earlier documents (e.g., PNNL-16887). The combined moisture-retention properties for the CCU and Taylor Flat member of the Ringold Formation within the vadose zone have high capacity to absorb and retain moisture.

3.1.2 Geochemical Considerations

The solubility and subsequent mobility of waste constituents in pore fluid depend on the container, chemical nature of the waste constituents and natural subsurface geochemical conditions.

Pore fluid in the unsaturated and saturated zones beneath LLBG Trenches 31 and 34 is slightly alkaline ($7<pH<8$), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic matter means that conditions are generally oxidizing. Calcium carbonate is also abundant in vadose zone sediment. These general conditions favor sorption or retardation of many heavy metals (e.g., lead) and favor formation of anionic species, which enhances mobility for other metals (e.g., hexavalent chromium). Laboratory sorption studies have documented these effects and related mobility issues in Hanford Site media.

3.1.3 Soil Moisture Factors

With the exception of waste in sealed metal or concrete containers (e.g., retrievable waste), direct precipitation is the primary driver for hypothetical leaching of waste constituents from the burial trenches and subsequent transport to groundwater. The amount of natural infiltration that can pass through the leachable buried waste and drain to the water table is controlled by the trenches' drainage and leachate collection systems. After the operational lifespan of LLBG Trenches 31 and 34 is complete, the texture of the cover and backfill, as well as the amount of vegetative cover, will also control natural infiltration to a large degree.

Stratigraphic features in the soil column beneath LLBG Trenches 31 and 34 can also influence or slow the downward migration by spreading soil moisture laterally. Direct observational evidence to assess this effect at LLBG Trenches 31 and 34 is lacking. Under the gravity drainage assumption, only a small to moderate horizontal gradient component is likely to be available to produce lateral spreading of infiltrating water.

It is estimated that recharge rates at the Hanford Site range from nearly 0 mm/yr at highly vegetated sites to greater than 50 mm/yr at gravel-covered, nonvegetated sites (PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).

3.1.4 Hydrogeologic Considerations

Prior to startup of the 200 West P&T system in 2012, the groundwater flow direction under LLBG Trenches 31 and 34 was east-northeast at a calculated rate (using the Darcy relationship) of 0.04 to 0.15 m/day. The water table in this region has increased in response to groundwater injection, and the groundwater flow direction across the trenches (east of injection wells 299-W10-35 and 299-W10-36) is now east to east-southeast as a result of groundwater extraction for the 200 West P&T with a calculated rate of 0.18 to 0.73 m/day (0.59 to 2.4 ft/day) (DOE/RL-2016-09).

These conditions are expected to remain while the 200 West P&T system is operational. After completion of active groundwater remediation and the 200 West P&T is shut down, groundwater flow is anticipated to return to pre-200 West P&T startup conditions. The changing groundwater flow directions and gradients will be considered when evaluating the groundwater monitoring network. These factors are assessed in evaluating impact to groundwater beneath LLBG Trenches 31 and 34 in the simulations described in Chapters 4 through 6 of this report.

3.1.5 Groundwater Chemistry

The groundwater monitoring results from the 200-ZP-1 OU and the current RCRA monitoring program are discussed in this section.

Groundwater in the saturated zones beneath LLBG Trenches 31 and 34 is slightly alkaline (7<pH<8), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic matter means that conditions generally are oxidizing. The dissolved oxygen concentrations fall into the higher range for groundwater (7 to 10 mg/L). These general conditions favor sorption or retardation of many heavy metals (e.g., lead) and also favor formation of anionic species, which enhance mobility for other metals (e.g., hexavalent chromium). These conditions tend to allow chlorinated solvents (e.g., carbon tetrachloride) to remain persistent, as these compounds normally degrade in more reducing groundwater environments.

Regional groundwater contaminant sources are identified through *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* remedial investigation activities at the 200-ZP-1 OU. The 200-ZP-1 OU comprises the groundwater beneath an area in the northwestern portion of the 200 West Area. Monitoring results for the 200-ZP-1 OU have shown that groundwater historically upgradient of the trenches has been contaminated from other sources in the 200 West Area.

The principal contaminant plume from the 200 West Area that is present in the saturated zone under LLBG Trenches 31 and 34 is carbon tetrachloride. LLBG Trenches 31 and 34 are located immediately adjacent to or within the northwestern edges of this large regional plume. In this area of the plume, the concentrations are above the drinking water standard (DWS) for carbon tetrachloride (5 µg/L).

Nitrate is another contaminant plume from the 200 West Area that is affecting LLBG Trenches 31 and 34. LLBG Trenches 31 and 34 are located immediately adjacent to or within the edges of this large regional plume. In this area of the plume, the concentrations are currently low and close to the DWS for nitrate (45 mg/L).

3.2 Monitoring Program Waste Constituents

As discussed in the conceptual site model, the potential for migration of substantial amounts of contamination from the vadose zone to groundwater is small because of the CCU, which inhibits downward migration from the surface to groundwater. An evaluation of the dangerous waste inventory disposed in LLBG Trenches 31 and 34 was performed to assess the specific dangerous waste constituents to include in the groundwater monitoring program for the trenches. This section also provides the selection process used for the indicator parameters.

3.2.1 Selection Process for Indicator Constituents

The selection process identifying indicator constituents included the following steps:

1. List the constituents in the waste inventory that are also on the dangerous constituent groundwater monitoring list in Ecology Publication 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, Appendix 5, excluding lead considering its less mobile and less

soluble characteristics. This provides a list of candidate constituents that may be subject to the indicator monitoring.

2. Query the Solid Waste Information and Tracking System database for an inventory of actual waste shipments delivered to LLBG Trenches 31 and 34 and summing the inventory mass, volume, and number of waste containers for the list of waste constituents.

3. Calculate the concentration for each waste constituent assuming all the waste inventory is absorbed into one pore volume of water from the trench to the water table. As identified in Section 3.1.1, the pore volume beneath the both trenches to the water table is 13,070 m^3 (3,450,000 gal). Identify a subset of this list as the dangerous constituents subject to the groundwater protection standards of WAC 173-303-645(4) by excluding those constituents with calculated concentrations below groundwater protection standards. The subset of waste constituents is provided in Table 3-1. Note that constituents may be excluded per WAC 173-303-645(4)(b).

4. Identify possible monitoring indicators based primarily on quantity, detectability, solubility, distribution coefficient (K_d), and mobility. Note that a constituent's K_d value is usually empirically determined and is based on local site conditions, as well as the constituent's chemical properties. A low K_d value generally indicates that a chemical has greater potential to migrate through the vadose zone and reach groundwater.

3.2.2 Composition of Waste Packages

Applying steps 1 and 2 of the indicator constituents selection process (Section 3.2.1), the list of candidate constituents that may be subject to the indicator monitoring is presented in Table A-1 (Appendix A) which summarizes the dangerous waste constituent inventory in Trenches 31 and 34 and identifies the following information:

- Waste constituent Chemical Abstracts Service number
- Waste constituent description
- Number of waste containers containing the waste constituent
- Combined volume of waste containers for each constituent
- Total weight of the waste constituent in all containers

All waste constituents in LLBG Trenches 31 and 34 were considered in this evaluation. Table 3-1 lists the subset of waste constituents from Table A-1 (Appendix A) where the total inventory transported by the assumed pore water volume exceeds federal regulation standards or WAC 246-290-310, "Group A Public Water Supplies," "Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs)." The waste constituents for possible monitoring indicators are identified in Table 3-1 along with justification based primarily on quantity, detectability, solubility, K_d, and mobility.

The leachate from the trench leachate system was also evaluated for dangerous constituents to include in the groundwater monitoring program. Leachate sample results are provided in Table A-2 (Appendix A). From the leachate data, Table 3-2 summarizes the dangerous constituents in the leachate above the maximum contaminant level (MCL) or maximum residual disinfectant level (MRDL). Three constituents (aluminum, arsenic, and uranium) had detections exceeding the MCL or MRDL. As identified in Table 3-2, only arsenic is proposed as an indicator parameter from the leachate samples because samples with concentrations above the MCL or MRDL for aluminum and uranium had laboratory qualifiers.

Table 3-1. Dangerous Constituents (Excluding Lead) from LLBG Trenches 31 and 34

Dangerous Constituent	Combined Waste Inventory (kg)	% of Containers with Waste Constituent	% of Total Waste Volume	Times Over MCL or MRDL Assuming All Inventory Released	Justification for Selection as Proposed Analytes	Proposed Final List of Indicator Parameters? (Yes/No)
1,1,1-trichloroethane	334.77	68%	77%	5.82	High inventory, high solubility, low K_d,	Yes
1,1,2,2-tetrachloroethane	0.60	1%	2%	12.24	--	No
1,1,2-trichloroethane	2.56	3%	1%	15.30	--	No
1,1-dichloroethylene	7.78	9%	15%	5.38	--	No
1,2-dichloroethane	8.32	7%	15%	98.88	--	No
2,4-dinitrotoluene	11.25	11%	20%	164.94	--	No
4-methyl-2-pentanone	164.99	65%	75%	1.77	High inventory, high solubility, low K_d	Yes
Arsenic	23.39	12%	23%	11.85	Medium inventory, very soluble in high pH >10	Yes
Benzene	20.77	15%	23%	128.81	Medium inventory, low K_d,	Yes
Bis(2-chloroethyl)ether	5.97	6%	1%	685.15	--	No
Cadmium	222.81	18%	32%	5.62	High inventory, medium solubility, high K_d	Yes
Carbon tetrachloride	348.22	20%	25%	30605.04	--	No
Chloroform	18.79	9%	19%	69.26	--	No
Dichloromethane	284.00	73%	82%	399.06	High inventory, moderate solubility, low K_d,	Yes
Ethylbenzene	4.72	8%	10%	3.23	--	No
Heptachlor	0.52	2%	2%	2.44	--	No
Hexachloroethane	8.43	6%	14%	1.22	--	No
Mercury	249.97	19%	38%	2.06	High inventory	Yes
Nitrobenzene	8.33	8%	15%	1.94	--	No

Table 3-1. Dangerous Constituents (Excluding Lead) from LLBG Trenches 31 and 34

Dangerous Constituent	Combined Waste Inventory (kg)	% of Containers with Waste Constituent	% of Total Waste Volume	Times Over MCL or MRDL Assuming All Inventory Released	Justification for Selection as Proposed Analytes	Proposed Final List of Indicator Parameters? (Yes/No)
P-cresol	28.43	16%	18%	1.48	--	No
P-dichlorobenzene	8.30	7%	15%	1.20	--	No
Pentachlorophenol	13.51	7%	15%	22.68	--	No
Tetrachloroethylene	26.15	15%	19%	59570.44	--	No
Toluene	225.24	20%	26%	1.20	High inventory, low K_d,	Yes
Trichloroethylene	26.88	15%	18%	207.40	--	No
Vinyl chloride (chloroethylene)	85.70	7%	15%	9222.51	--	No

-- = constituent not proposed as indicator parameter

K_d = distribution coefficient

MCL = maximum contaminant level

MRDL = maximum residual disinfectant level

Table 3-2. Mixed Waste Trench Leachate Constituents Above the MCL or MRDL

Dangerous Constituent	No. of Samples with Concentrations Above MCL or MRDL	No. of Samples Analyzed for Constituent	Comment	Proposed Final List of Indicator Parameters? (Yes/No)
Aluminum	4	8	Samples with concentrations above MCL or MRDL had lab qualifiers	No
Arsenic	8	8	Detected above MCL or MRDL in all samples in data set analyzed for arsenic	Yes
Uranium	1	38	Sample with concentration above MCL or MRDL had lab qualifier	No

MCL = maximum contaminant level
MRDL = maximum residual disinfectant level

The dangerous waste constituents proposed as indicator parameters for groundwater detection monitoring based on the above evaluation are presented in Table 3-3.

Table 3-3. Proposed Indicator Parameter Dangerous Waste Constituents

Dangerous Constituent
4-Methyl-2-Pentanone
Toluene
Benzene
1,1,1-Trichloroethane
Mercury
Arsenic
Cadmium
Dichloromethane

As guided by the *Washington Administrative Code* (WAC), only the dangerous waste constituents listed in Table 3-3 will be used to determine if there is statistically significant evidence of contamination from LLBG Trenches 31 and 34.

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4 Groundwater Flow Simulations

Groundwater flow simulations were conducted to evaluate a proposed groundwater monitoring network for detection of significant increases in groundwater contamination under the influence of the 200 West P&T and post-P&T operations. The Central Plateau groundwater model (CPGWM) is the principal computational tool (CP-47631, Rev. 0, *Model Package Report: Central Plateau Groundwater Model Version 3.3*) used to simulate groundwater flow and evaluate the performance of the 200 West P&T groundwater remedy. The current version (6.3.3) of the CPGWM simulates groundwater flow using the U.S. Geological Survey three-dimensional groundwater flow model (MODFLOW) discussed in the following documents:

- McDonald and Harbaugh, 1988, "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model"
- Harbaugh and McDonald, 1996, *User's Documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model*
- Harbaugh et al., 2000, *MODFLOW 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process*
- Harbaugh, 2005, *MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model – The Ground-Water Flow Process*

Contaminant transport is simulated using the Modular 3-D Transport Multispecies (MT3DMS) code (Zheng and Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*; Zheng, 2010, *MT3DMS v5.3 Supplemental User's Guide*). MT3DMS is a three-dimensional, multispecies transport model developed specifically for use with MODFLOW to simulate contaminant advection, dispersion, and chemical reactions in groundwater. MT3DMS was used to calculate approximate directions and rates of migration of the 200-ZP-1 contaminants of concern and approximate time varying influent concentrations and masses of these contaminants at the extraction wells and at the combined system influent. The particle-tracking post-processor MODPATH (Pollock, 1994, *User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U.S. Geological Survey finite-difference ground-water flow model*) is used to compute pathlines based upon results obtained from the CPGWM flow simulations.

4.1 Simulation Scenarios

Table 4-1 identifies the simulation scenarios run for this evaluation. The scenarios were selected to provide a bounding set of conditions expected near LLBG Trenches 31 and 34 during P&T (until year 2037) and post-P&T operations.

Three scenarios were identified:

- Scenario 1 provides particle tracking simulations to evaluate influence to the LLBG Trenches 31 and 34 monitoring network with the 200 West P&T operating at total current operating flow rate of 8782 L/min (2,320 gpm).
- Scenario 2 provides particle tracking simulations to evaluate influence to the LLBG Trenches 31 and 34 monitoring network with the 200 West P&T operating at the planned expanded capacity of 9,464 L/min (2,500 gpm).

- Scenario 3 provides for particle tracking simulation with the 200 West P&T shut down following the active remediation period.

Scenarios 1 and 2 both include six subscenarios (A through F) to evaluate changes in flow rates to the IWs (299-W10-35 and 299-W15-226). Flow rates to the two IWs for cases A through F are provided in Table 4-1. The subscenario flow rates include the following:

A. Nominal injection rates to IWs 299-W10-35 and 299-W15-226.

B. IW 299-W10-35 operating at 50 percent nominal pumping rate with other IW pumping rates adjusted to maintain total pumping rate at the 200 West P&T operating capacity.

C. No pumping to IW 299-W10-35 with other IW pumping rates adjusted to maintain total pumping rate at the 200 West P&T operating capacity.

D. IW 299-W15-226 operating at 50 percent nominal pumping rate with other IW pumping rates adjusted to maintain total pumping rate at the 200 West P&T operating capacity.

E. No pumping to IW 299-W15-226 with other IW pumping rates adjusted to maintain total pumping rate at the 200 West P&T operating capacity.

F. No pumping to IW 299-W10-35 with other IW pumping rates adjusted to maintain total pumping rate at the 200 West P&T operating capacity.

Each subscenario in Table 4-1 is weighted on a normalized scale of 0 to 100 percent, indicating the likelihood of operating under operating condition of the subscenario. Table 4-2 in ECF-200ZP1-16-0054 (Appendix B) provides pumping rates for the 200 West P&T extraction and injection wells Scenarios 1 and 2. Simulations were run for each scenario to look at dilution from nearby IWs 299-W10-35 and 299-W15-226 and particle tracking of potential releases from LLBG Trenches 31 and 34 to evaluate monitoring well locations for detection of potential releases.

Scenario 3 provides particle tracking for evaluating the LLBG Trench 31 and 34 monitoring network for releases when the 200 West P&T remedy is complete and no longer operating.

4.2 Particle Tracking and Transport Modeling

The particle tracking program MODPATH was executed to track the particles, and the results were post-processed and superimposed upon figures together with injection and monitoring wells to determine if monitoring locations lie in the migration pathway of any potential releases from the trenches, and if monitoring locations lie in the migration pathway of reinjected water. To simulate dispersion with particle tracking, the Random-Walk tracking option within MODPATH was used.

To evaluate the efficacy of the groundwater monitoring network to detect potential releases from LLBG Trenches 31 and 34, two distinct but complementary transport simulations were performed:

- Simulation of treated water reinjection, using the unit source approach to represent the water reinjected at injection wells

- Simulation of a potential release that impacts the water table below Trenches 31 and 34, using the unit source approach to represent the water table impact and subsequent migration from LLBG Trenches 31 and 34

Particles were tracked for both releases at IWs 299-W10-35 and 299-W15-226 and releases from Trenches 31 and 34 for the equivalent of 26 years (period of 200 West P&T active remedy). Particle tracking was performed for each of the simulation scenarios identified in Table 4-1. Specific details on generation of the input files, water level maps, particle tracking, and post-processing of the output data are provided in ECF-200ZP1-16-0054, *Groundwater Flow and Migration Calculations to Support Assessment of the LLWMA-3 Trenches 31 and 34 Monitoring Network* (see Appendix B).

Table 4-1. Simulation Scenarios

Scenario	Sub-scenario	P&T System Capacity (gpm)	Description	Scenario Weight (%)
1	A	2,320	Current conditions.	74%
	B	2,320	Current, but with injection well 299-W10-35 operating at 50 percent.	10%
	C	2,320	Current, but with injection well 299-W10-35 not operating.	5%
	D	2,320	Current, but with injection well 299-W15-226 operating at 50 percent.	5%
	E	2,320	Current, but with injection well 299-W15-226 not operating.	5%
	F	2,320	Current, but with both injection wells 299-W10-35 and 299-W15-226 not operating.	1%
2	A	2,500	Full capacity. Injection wells 299-W10-35 and 299-W15-226 at current rates; remainder rebalanced.	74%
	B	2,500	Full capacity. Rates as per scenario 2A, except injection well 299-W10-35 operating at 50 percent; remainder rebalanced.	10%
	C	2,500	Full capacity. Rates as per scenario 2A, except injection well 299-W10-35 not operating; remainder rebalanced.	5%
	D	2,500	Full capacity. Rates as per scenario 2A, except injection well 299-W15-226 operating at 50 percent; remainder rebalanced.	5%
	E	2,500	Full capacity. Rates as per scenario 2A, except injection well 299-W15-226 not operating; remainder rebalanced.	5%
	F	2,500	Full capacity. Rates as per scenario 2A, except injection wells 299-W15-35 and 299-W15-226 not operating; remainder rebalanced.	1%
3	A	0	System shutdown following active P&T.	100%

Note: For dilution calculations, unit concentration released at injection well corresponding with initiation of each injection well (i.e., using actual dates/timing).

For release calculations, unit concentration released at each trench assuming late 2015 release date.

gpm = gallons per minute

IW = injection well

P&T = pump and treat

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5 Flow Model Calibration

During 2009 and 2010, the groundwater model underwent development and recalibration and was reissued via a series of model package reports as the CPGWM. The most recent model package report describing the CPGWM was released in 2015 (CP-47631, Rev. 2, *Model Package Report: Central Plateau Groundwater Model Version 6.3.3*).

Simulated groundwater elevations are computed using the CPGWM, which is a calibrated and flow conserved numerical simulator of groundwater in the Central Plateau. Since previous efforts were completed to calibrate the flow model parameters, the flow model outputs (i.e., heads) in general correspond with measured water levels throughout the area. However, the accuracy of the simulated groundwater elevations (and of inferences from those elevations, such as the extent of hydraulic containment) are influenced by the structural accuracy of the CPGWM (i.e., how well the model represents actual physical conditions); accuracy of the water-level data used for calibration; magnitude and distribution of validation calibration residuals; and other factors. These and other potential sources of error in the simulated groundwater contours, drawdown and mounding, and extent of hydraulic containment result in the simulated depictions only approximating actual conditions. As such, the simulated water levels are interpreted as reasonable approximations that provide value when interpreting the likely directions and rates of groundwater movement, and the likely extents of convergent hydraulic gradients that are consistent with hydraulic containment. Comparison of the groundwater-level maps and the extent of hydraulic containment as simulated using the CPGWM with the depictions obtained using the described water-level mapping technique can provide confidence in the results obtained as follows:

- In areas where the estimated extent of hydraulic containment is similar between the methods, confidence is relatively high that containment is being achieved (if both methods suggest containment is achieved) or is not being achieved (where both methods suggest containment is not achieved).
- In areas where the estimated extent of hydraulic containment differs substantially between the methods, confidence is lower in the interpretation of containment because one method suggests containment is being achieved, while the other suggests it is not.

Calibration targets for the CPGWM were updated with available continuous and manually measured water-level data through December 2014. Daily average water-level values were calculated for incorporation into the validation calibration data set. Figure 5-1 illustrates comparisons of simulated and measured water levels at selected wells. Summary statistics for the validation/calibration residuals are presented in ECF-Hanford-15-0002, *Description of Groundwater Calculations and Assessments for the Calendar Year 2014 (CY2014) 200 Areas Pump-and-Treat Report* (pending). The summary statistics presented in ECF-Hanford-15-0002 suggest that over the extended validation period (from 2009 through 2014), the model performs as well (in terms of statistical correspondence with measured water levels) as during the calibration period.

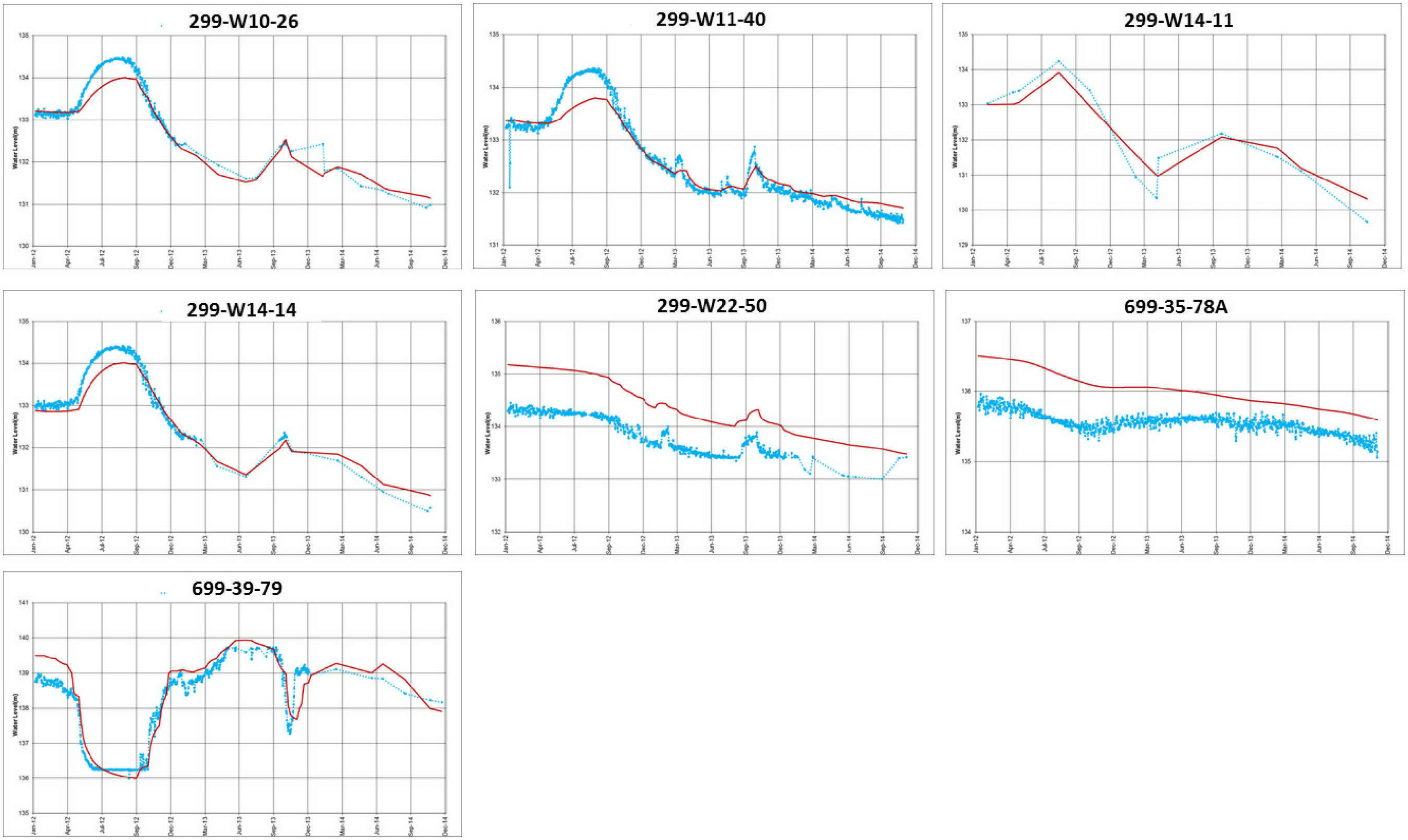

Figure 5-1. Selected Water-Level Hydrographs Throughout the Study Area Illustrating the Correspondence Between Simulated and Measured Groundwater Elevations

6 Simulation Results and Conclusions

This chapter presents output from the simulation scenarios listed in Table 4-1. For Scenarios 1 and 2, Subscenario A-F, the composite maps and unit transport calculations are based on the assumptions in Appendix B of ECF-200-ZP1-16-0054, which includes the following:

- Pathline calculations
  - Release of particles from around IWs 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226
  - Release of particles to the water table from the approximate east-central section of LLBG Trenches 31 and 34
  - Track particles through 2037, which is when the 200-ZP-1 P&T will cease operation
- Dilution calculations
  - Release unit concentrations (injected water unit concentration = 1.0) from the same four IWs
  - Track injected water through 2037, which is when the 200-ZP-1 P&T will cease operation
  - Composite plume maps of release pathlines superimposed over injected water dilution contours over time

Figures are produced to show the following features:

- Dilution trends for unit concentration release from 200 West P&T IWs to show influence of injected water at monitoring wells 299-W10-29 and 299-W10-30
- Trend curves for monitored concentrations at monitoring wells 299-W10-29 and 299-W10-30 for unit concentration release from LLBG Trenches 31 and 34 with dilution from 200 West P&T injection water
- Composite release plume map to show relative detectability of trench unit release at monitoring locations.

Scenario 3 provides particle tracking for evaluating the LLBG Trenches 31 and 34 monitoring network for releases when the 200 West P&T remedy is complete and no longer operating. In the case of the focused release tracking scenarios, the objective is to identify areas of the aquifer where a potential release that impacts the water table beneath the low point of the leachate collections system within Trenches 31 and 34 would be most likely to migrate and be detectable. Section 6.1 of ECF-200ZP1-16-0054 describes the process used for developing the "relative detectability" figures to illustrate the results of the calculations on a finer spatial resolution than the discretization of the CPGWM simulation grid. Details of the simulation are presented in ECF-200ZP1-16-0054 (Appendix B).

6.1 Scenario 1 Dilution Curves

The estimated dilution from 200 West P&T injected water at monitoring wells 299-W10-30 and 299-W10-29 for each of the six cases listed in Table 4-1 at the current 200 West P&T throughput (2,320 gpm) is shown in Figures 6-1 and 6-2, respectively. A unit concentration of 1 would indicate that groundwater flowing through the monitoring well is all injected water. The start of the simulation represents the year 2012 with startup of the 200 West P&T operations. Each test case is assumed to start in 2015, 3 years after startup of the 200 West P&T. This is reflected by the single trend line up to the year 2015 in Figures 6-1 and 6-2. Starting in 2015, flow rates to IWs are adjusted for each case in Table 4-1.

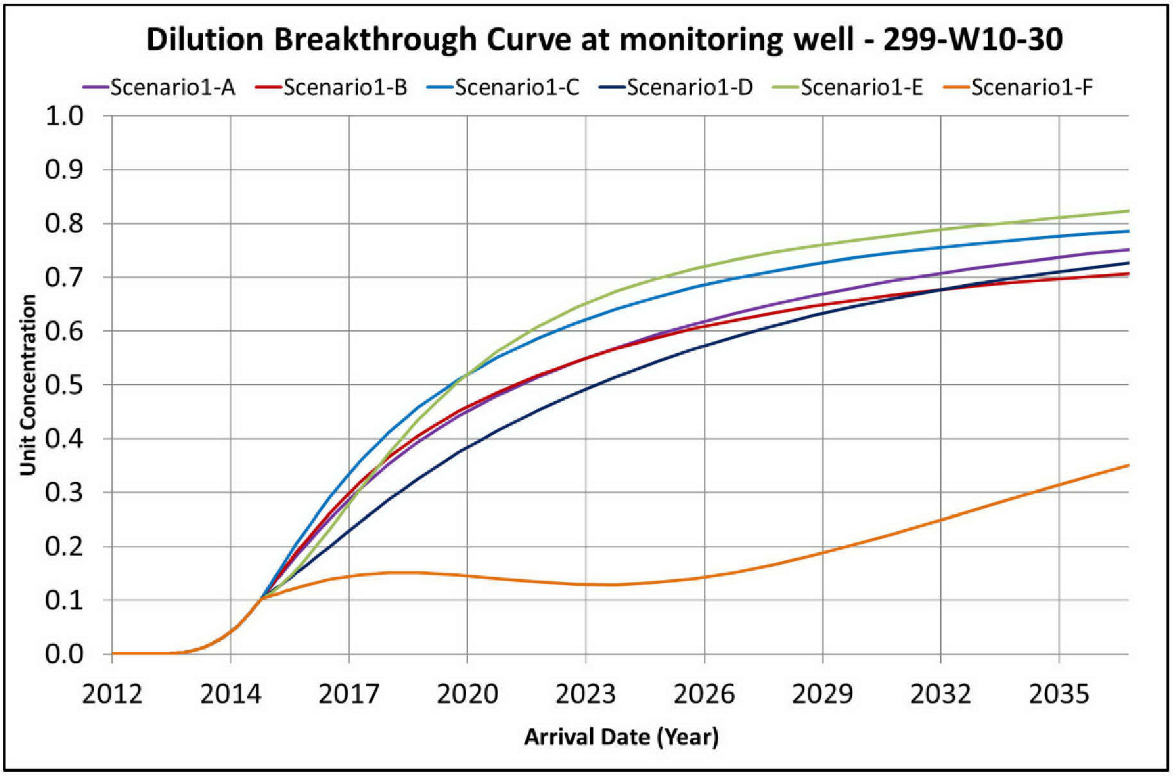

Figure 6-1. Injected Treated Water Dilution Curves at Monitoring Well 299-W10-30

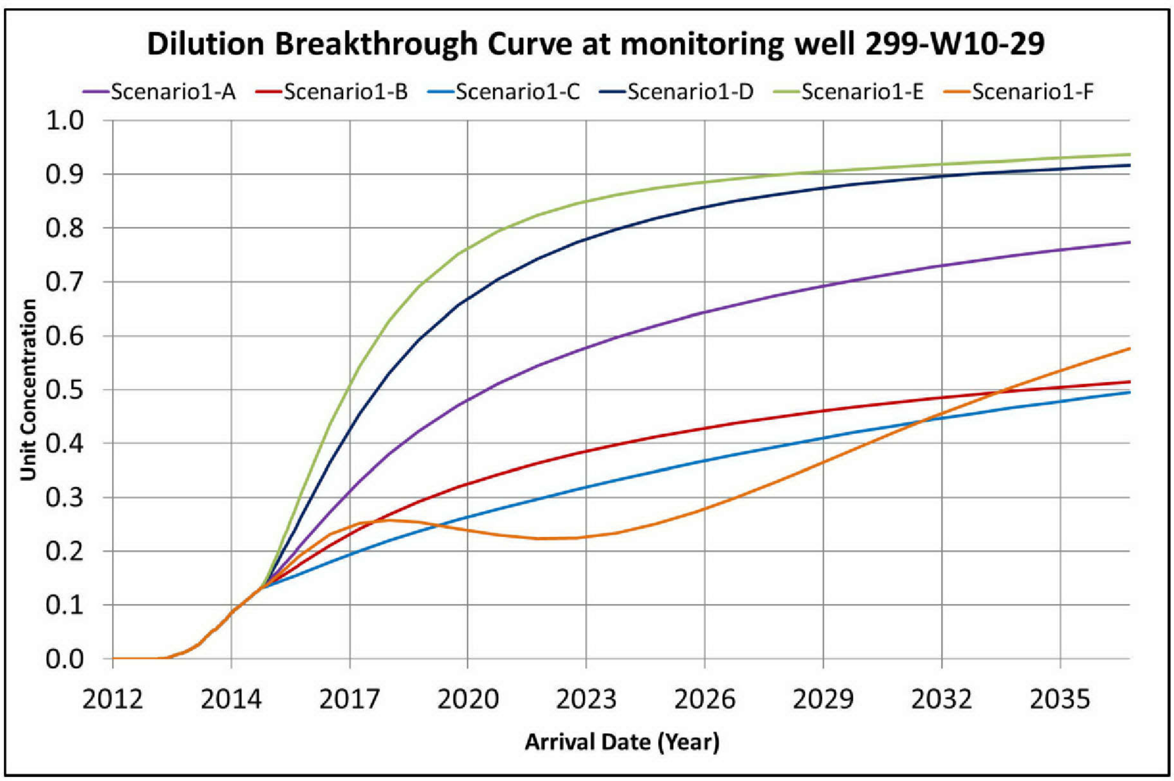

Figure 6-2. Injected Treated Water Dilution Curves at Monitoring Well 299-W10-29

Figures 6-1 and 6-2 show that the hydraulic effects of varying pumping rates to the two nearby injections wells (299-W10-35 to the north of the trenches and 299-W15-226 to the south of the trenches) influence concentrations observed differently at the two monitoring wells. The estimated dilution at monitoring wells 299-W10-30 and 299-W10-29 for the current design operating pumping rates to the IWs (299-W10-35 and 299-W15-226) are represented by the dilution curve for Scenario 1, Subscenario A in Figures 6-1 and 6-2, respectively. Reducing the pumping rate to IW 299-W10-35 (Scenario 1, Subscenario B in Figures 6-1 and 6-2) reduces the dilution influence to monitoring wells 299-W10-29 and 299-W10-30. However, shutting off pumping to IW 299-W10-35 (Scenario 1-C) results in an overall increase in dilution at monitoring well 299-W10-30 (Figure 6-1) and an overall decrease in dilution at monitoring well 299-W10-29 (Figure 6-2). The overall dilution increase at monitoring well 299-W10-30 is a result of hydraulic head decrease from shutting off pumping to IW 299-W10-35 allowing additional injection water from 299-W15-226 to reach the monitoring well.

Reducing the pumping rate to IW 299-W15-226 reduces dilution at monitoring well 299-W10-30 (Figure 6-1, Scenario 1, Subscenario D dilution curve), but it results in an overall dilution increase at monitoring well 299-W10-29 (Figure 6-2, Scenario 1, Subscenario D dilution curve). The overall dilution increase at monitoring well 299-W10-29 is a result of hydraulic head decrease from reducing pumping to IW 299-W15-226 allowing additional injection water from 299-W10-35 to reach the monitoring well. Shutting off pumping to IW 299-W15-226 (Scenario 1, Subscenario E in Figures 6-1 and 6-2) further reduces the hydraulic head south of Trenches 31 and 34 allowing more injected effluent from IWs north of the trenches to disperse towards the south resulting in increased dilution at monitoring wells 299-W10-29 and 299-W10-30.

Figure 6-1 illustrates there is less than a 20 percent difference in the dilution effect observed at monitoring well 299-W10-30 for Scenario 1, Subscenario cases A through E from injection to nearby IWs. For monitoring well 299-W10-29, there is a 50 percent difference between the span of Scenario 1, Subscenarios A through E (Figure 6-2).

Scenario 1, Subscenario-F evaluates dilution effects with pumping shut off to both IWs (299-W10-35 and 299-W15-226). The dilution curve for Scenario 1, Sub Scenario F is included in Figures 6-1 and 6-2. At monitoring well 299-W10-30 there is about two to three times less dilution estimated at the monitoring well between Subscenario F and Subscenarios A through E. The dilution curves at monitoring well 299-W10-29 indicate dilution for Scenario F reaches slightly higher than that observed for Scenario 1, Subscenario B (reduced pumping to IW 299-W10-35).

Additional detail for the simulated path of treated water that is reinjected at injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226 is provided in ECF-200ZP1-16-0054 (Appendix B). ECF-200ZP1-16-0054 provides map depictions for release particle tracking and dilution plume distribution that is simulated assuming unit sources of injected treated water at 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226.

6.2 Scenario 1 Release Dilution Breakthrough Curves

Figures 6-3 and 6-4 show the dilution curves for release of unit concentrations from Trenches 31 and 34 observed at monitoring wells 299-W10-30 and 299-W10-29, respectively. Dilution is defined as the ratio of concentration at a downgradient point (in this case, monitoring wells 299-W10-30 and 299-W10-29) to the original concentration of the release. For a unit concentration release, Figure 6-3 shows that the dilution at monitoring well 299-W10-30 ranges from 32 to 45 percent for Scenario 1, Subscenarios A through E and about 58 percent for Subscenario F with no pumping to injections 299-W10-35 and 299-W15-226. In each subscenario, 10 percent of the unit concentration release is observed at monitoring well 299-W10-30 within 2.5 years.

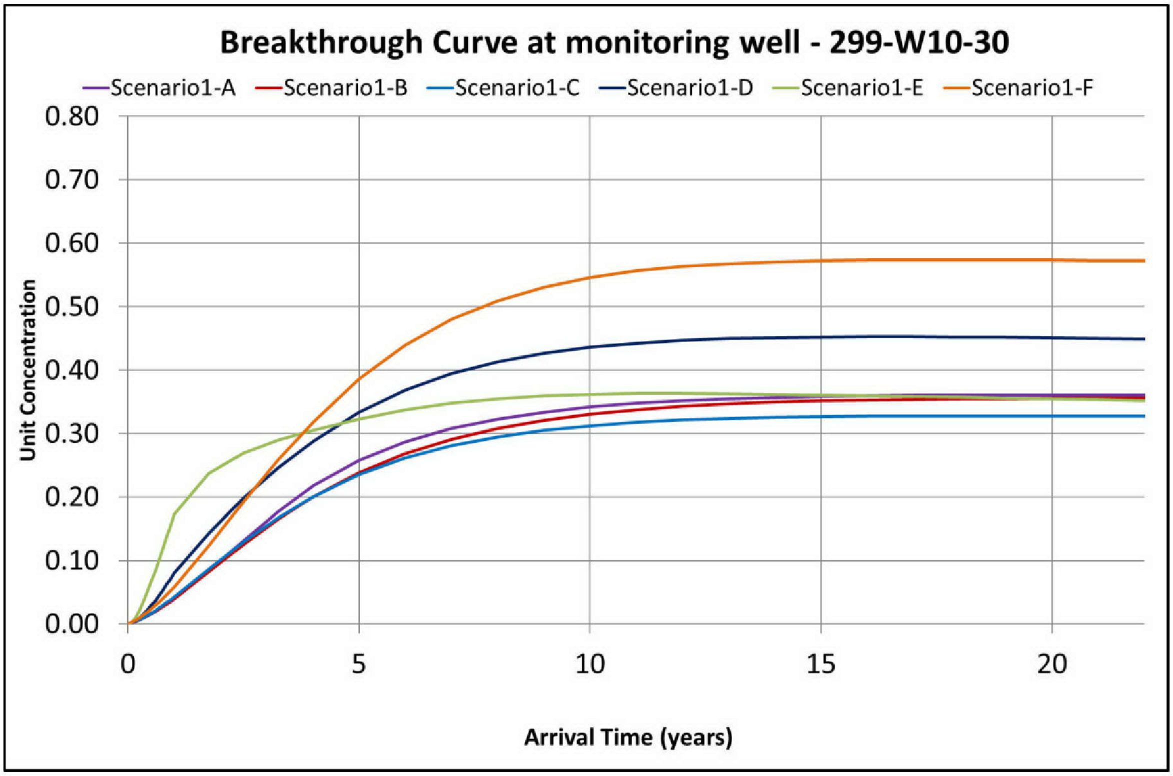

Figure 6-3. Release Concentration Curves at Monitoring Well 299-W10-30

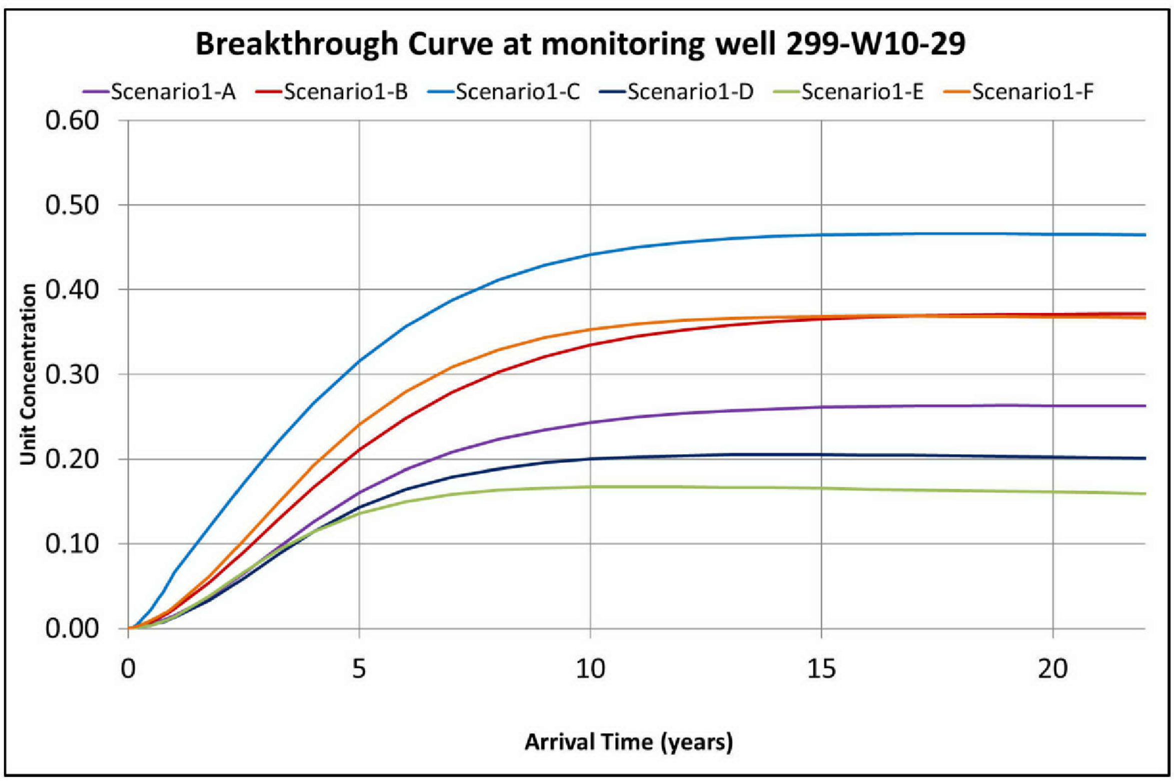

Figure 6-4. Release Concentration Curves at Monitoring Well 299-W10-29

Figure 6-4 shows the dilution for each of the test cases at monitoring well 299-W10-29 ranging from 15 to 47 percent. In each subscenario, 10 percent of the unit concentration release is observed at monitoring well 299-W10-29 within 4 years.

Table 6-1 shows a range of hypothetical release concentrations from LLBG Trenches 31 and 34 to determine if a release would be successfully detected. The range reflects release concentrations if 100 percent, 10 percent, or 1 percent of the waste constituent inventory in the trenches were transported to groundwater by infiltration of one vadose zone pore volume of water. The calculated waste constituent concentration to groundwater is above the constituent method detection limit (MDL) (Table 6-1). Table 6-1 includes the percent of the waste constituent inventory from the trenches that would need to be released for detection above the MDL at the monitoring wells based on the dilution breakthrough curves in Figures 6-3 and 6-4. The breakthrough percentage range for all subscenarios of scenario 1 is 15 to 58 percent. The percent of total inventory released for detection above the MDL for each waste constituent at the monitoring locations for Subscenario 1A is presented separately in Table 6-1 since this reflects the most likely 200 West P&T injection well flow rates and pumping conditions. Except for arsenic, a release of less than 1 percent of the total inventory will be detectable above the MDL for each waste constituent. Arsenic is detectable above the MDL for releases of 1.1 to 4.5 percent of the arsenic inventory in the trenches for all subscenarios, and releases of 1.9 to 2.5 percent for Subscenario 1A.

Table 6-1. Waste Constituent Breakthrough Concentration Range for Scenario 1

	Concentration for Percent of Waste Constituent Released in 1 Vadose Zone Pore Volume (µg/L)					
Waste Description	**100%**	**10%**	**1%**	**MDL* (µg/L)**	**Percent of Waste Constituent Inventory to Detect at 58% - 15% Breakthrough – All Scenarios (µg/L)**	**Percent of Waste Constituent Inventory to Detect at 27% - 35% Breakthrough – Scenario 1A (µg/L)**
4-Methyl-2-pentanone	1262.3	126.2	12.6	0.12	0.02% - 0.06%	0.03% - 0.04%
Toluene	1723.3	172.3	17.2	1.1	0.11% - 0.43%	0.18% - 0.24%
Benzene	158.9	15.9	1.6	0.064	0.07% - 0.27%	0.12% - 0.15%
1,1,1-trichloroethane	2561.4	256.1	25.6	0.069	0.% - 0.02%	0.01% - 0.01%
Mercury	1912.6	191.3	19.1	0.06	0.01% - 0.02%	0.01% - 0.01%
Arsenic	179.0	17.9	1.8	1.2	1.16% - 4.47%	1.92% - 2.48%
Cadmium	1704.7	170.5	17.0	0.1	0.01% - 0.04%	0.02% - 0.02%
Dichloromethane	2172.9	217.3	21.7	0.21	0.02% - 0.06%	0.03% - 0.04%

* As reported in laboratory analysis from Test America St. Louis.

MDL = method detection limit

6.3 Scenario 1 Composite Map Depicting Relative Detectability

Additional detail for the simulated path of unit release concentrations for each subscenario presented in Table 4-1 is provided in ECF-200ZP1-16-0054 (see Appendix B). Maps are provided in Figures 7-7 through 7-12 of ECF-200ZP1-16-0054 depicting release particle tracking and dilution plume distribution. These figures show the dilution plume from the IWs superimposed with particle track flow pathlines for release from LLBG Trenches 31 and 34 for cases A through F for Scenario 1.

Figure 6-5 is a composite depiction map of the relative detectability distribution for a unit release based on the six Scenario 1 simulations (Scenario 1, Subscenarios A through F) as defined in Table 4-1. The relative detectability was determined by calculating, for each scenario, the number of released particles that traversed each simulation model subgrid cell, and then computed a weighted sum of these counts resulting in a value lying between 0 and 1 for each subgrid cell, as follows:

$$RD = \frac{1}{MNP}\sum_{1}^{n} P_i N_i$$

where

RD	=	relative detectability (ranging from zero to one)
MNP	=	maximum number of particles that traversed any subgrid cell in all scenarios
P_i	=	ascribed weight or probability of subscenario *i* (as listed in Table 4-1)
N_i	=	number of particles that traversed the calculation subgrid cell during subscenario *i*
n	=	total number of subscenarios within the simulated scenario (i.e., 6, as listed in Table 4-1)

The resulting map of relative detectability (Figure 6-5) shows the overall distribution for a unit release from the trenches taking into account both advection and dispersion. The release distribution is color coded to reflect the weighted percent distribution of particle counts throughout the release pathline. Where the weighted percent distribution of particle counts is higher, the probability of release detection is also higher. The relative detectability map (Figure 6-5) shows that existing downgradient groundwater monitoring wells 299-W10-29 and 299-W10-30 intersect hypothetical releases from the LLBG trenches in areas of higher percent distribution of particle releases. Three new monitoring locations are proposed as shown in Figure 6-5 with wells C9625, C9626, and C9627 to provide monitoring at the extents of the release pathline distribution and location with higher percent distribution. The three new wells are planned to intersect and detect potential contamination along the northern and southern region of the mapped hypothetical release. Along with upgradient well 299-W9-2, which is not impacted by the hypothetical release, the six well groundwater monitoring network (not to include 299-W10-31) is proposed for detection of contamination based on Scenario 1, Subscenarios A through F. Well 299-W10-31 (from the interim status network) is not included in the final status network because it is not at the point of compliance.

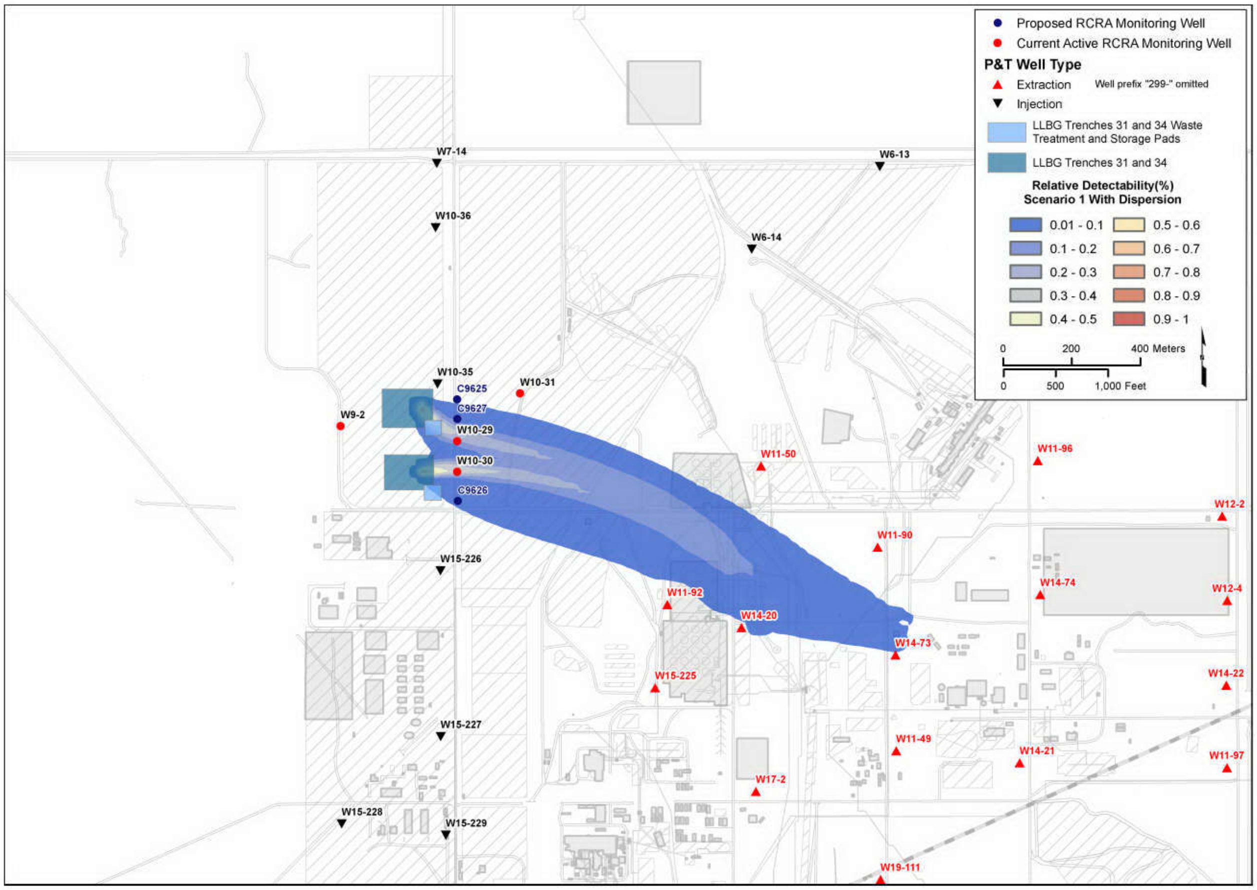

Figure 6-5. Relative Detectability of Release for Scenario 1

6.4 Simulation Plots for Scenario 2

Scenario 1, Subscenarios A through F were repeated in Scenario 2 with an increased flow rate from 2,320 gpm to 2,500 gpm (see Table 4-1). The dilution and release concentration curves for Scenario 2 (Figures 6-6 through 6-9) follow the same trends as Scenario 1 with little difference (within 5 percent) for each subscenario.

Table 6-2 shows a range of hypothetical release concentrations from Trenches 31 and 34 to determine if a release would be successfully detected for Scenario 2 simulations. The range reflects release concentrations if 100 percent, 10 percent, or 1 percent of the waste constituent inventory in the trenches were transported to groundwater by infiltration of one vadose zone pore volume of water. The calculated waste constituent concentration to groundwater is above the constituent MDL. Table 6-2 includes the percent of the waste constituent inventory from the trenches that would need to be released for detection above the MDL at the monitoring wells based on the dilution breakthrough curves in Figures 6-8 and 6-9. The breakthrough percentage range for all subscenarios of Scenario 2 is 16 to 60 percent. The percent of total inventory released for detection above the MDL for each waste constituent at the monitoring locations for Subscenario 2A is presented separately in Table 6-2 since this reflects the most likely 200 West P&T injection well flow rates and pumping conditions. Except for arsenic, a release of less than 1 percent of the total inventory will be detectable above the MDL for each waste constituent. Arsenic is detectable above the MDL for releases of 1.1 to 4.2 percent of the arsenic inventory in the trenches for all subscenarios, and releases of 1.9 to 2.5 percent for Subscenario 2A.

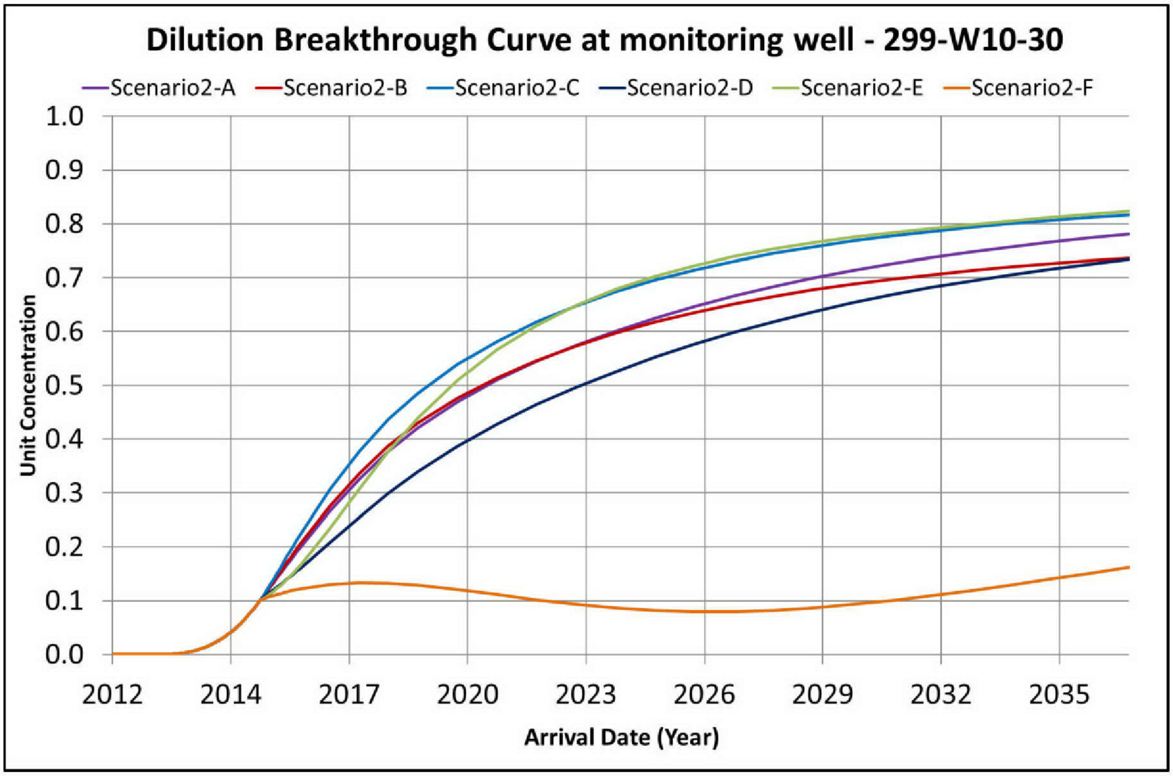

Figure 6-6. Scenario 2 Injected Treated Water Dilution Curves at Monitoring Well 299-W10-30

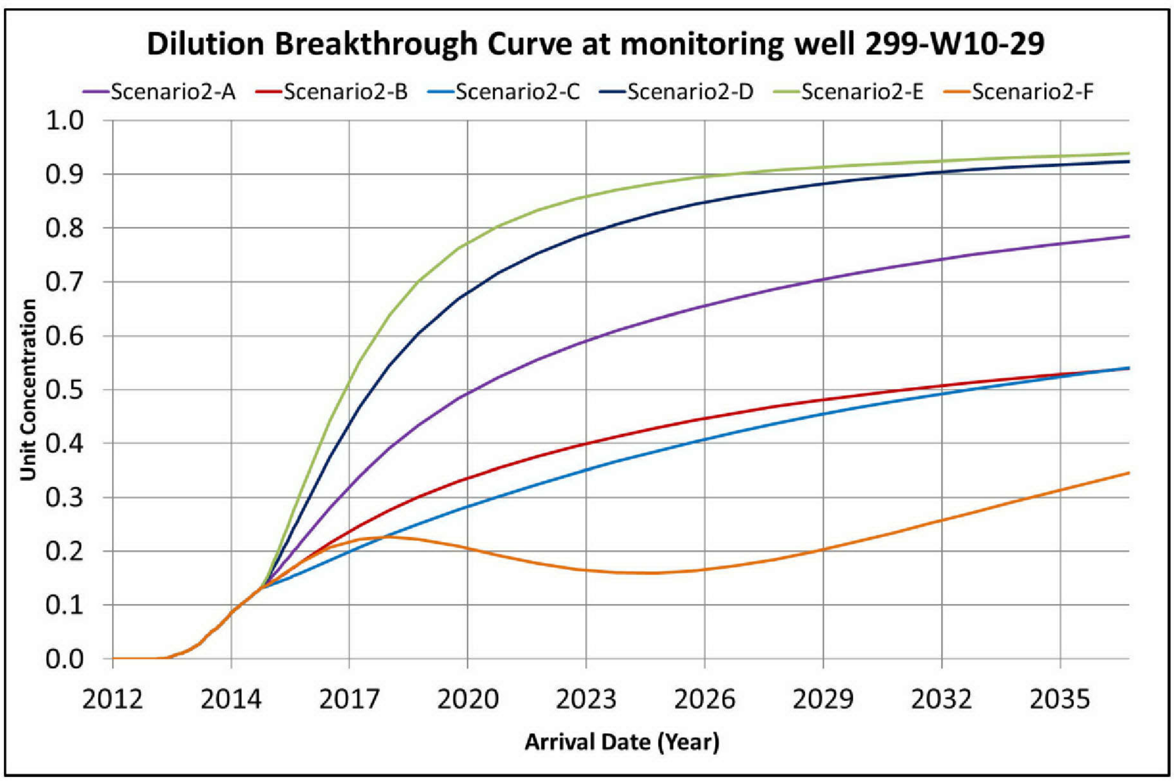

Figure 6-7. Scenario 2 Injected Treated Water Dilution Curves at Monitoring Well 299-W10-29

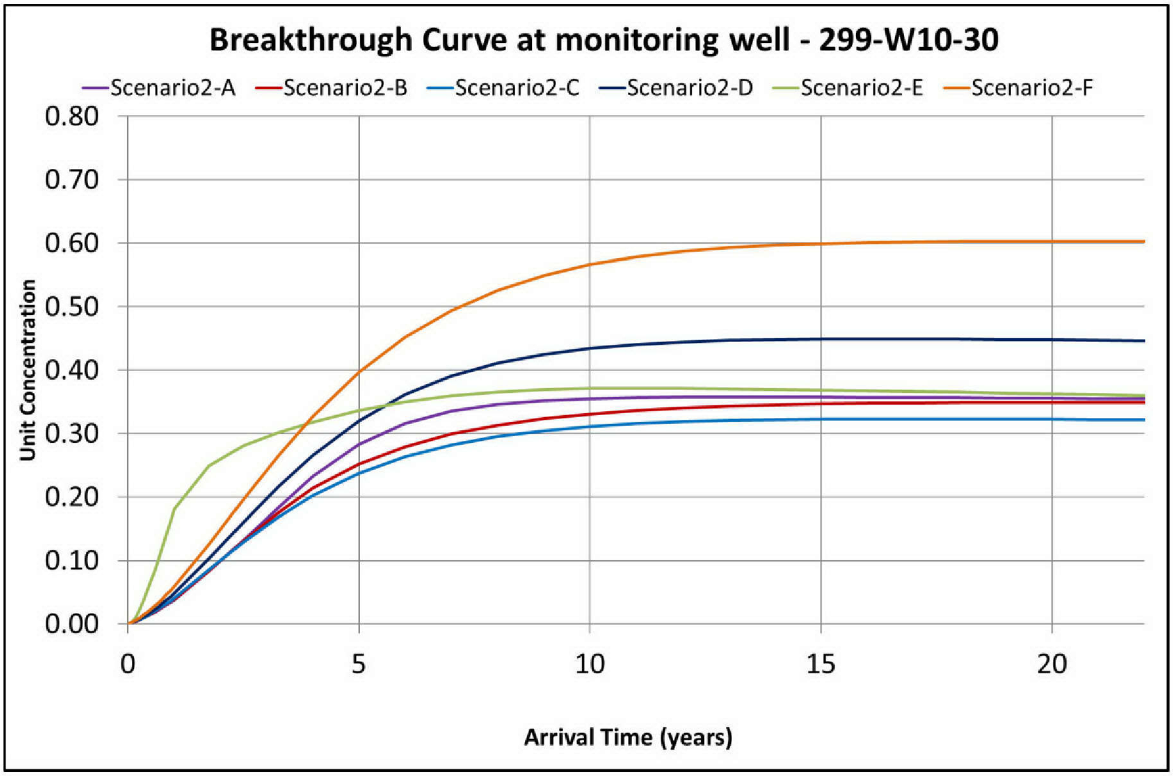

Figure 6-8. Scenario 2 Release Concentration Curves at Monitoring Well 299-W10-30

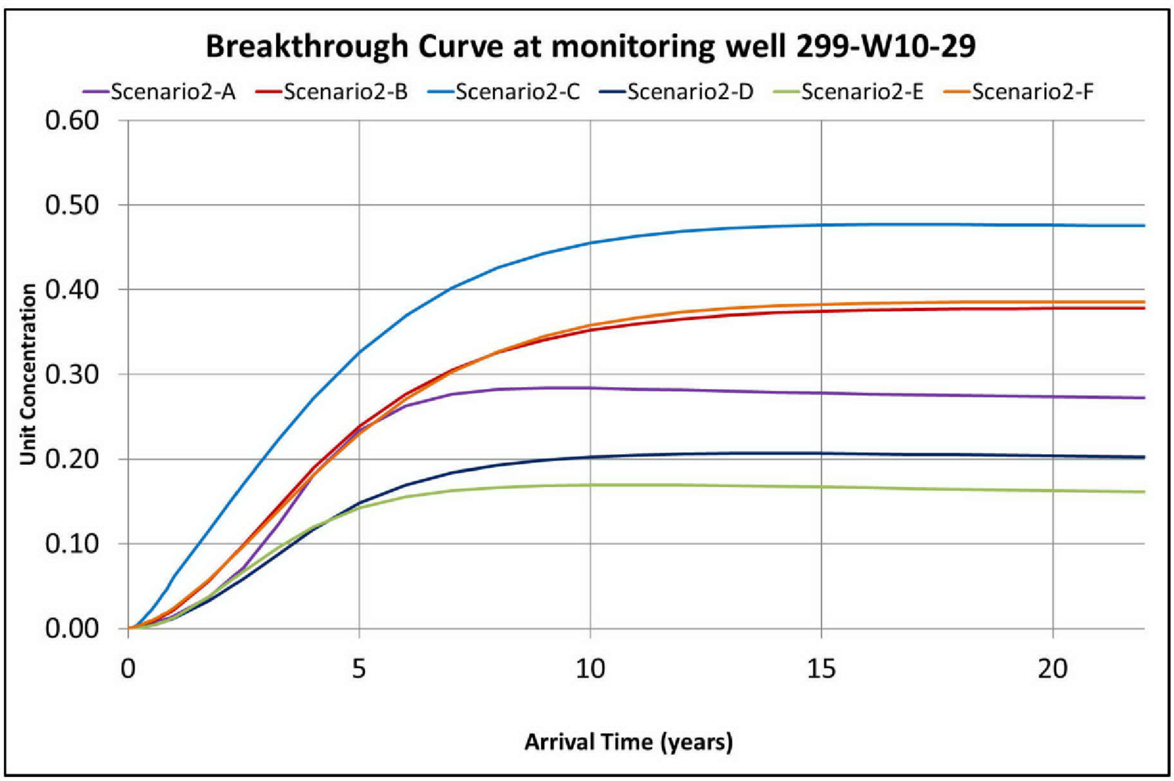

Figure 6-9. Scenario 2 Release Concentration Curves at Monitoring Well 299-W10-29

Table 6-2. Waste Constituent Breakthrough Concentration Range for Scenario 2

Waste Description	Concentration for Percent of Waste Constituent Released in 1 Vadose Zone Pore Volume (µg/L)			MDL* (µg/L)	Percent of Waste Constituent Inventory to Detect at 60% - 16% Breakthrough – All Scenarios (µg/L)	Percent of Waste Constituent Inventory to Detect at 27% - 35% Breakthrough – Scenario 2A (µg/L)
	100%	10%	1%			
4-Methyl-2-Pentanone	1262.3	126.2	12.6	0.12	0.02% - 0.06%	0.03% - 0.04%
Toluene	1723.3	172.3	17.2	1.1	0.11% - 0.4%	0.18% - 0.24%
Benzene	158.9	15.9	1.6	0.064	0.07% - 0.25%	0.12% - 0.15%
1,1,1-Trichloroethane	2561.4	256.1	25.6	0.069	0.% - 0.02%	0.01% - 0.01%
Mercury	1912.6	191.3	19.1	0.06	0.01% - 0.02%	0.01% - 0.01%
Arsenic	179.0	17.9	1.8	1.2	1.12% - 4.19%	1.92% - 2.48%
Cadmium	1704.7	170.5	17.0	0.1	0.01% - 0.04%	0.02% - 0.02%
Dichloromethane	2172.9	217.3	21.7	0.21	0.02% - 0.06%	0.03% - 0.04%

* As reported in laboratory analysis from Test America St. Louis.

MDL = method detection limit

6.5 Scenario 2 Composite Dilution Map.

Figure 6-10 is a composite depiction map of the relative detectability distribution for a unit release based on the six Scenario 1 simulations (Scenario 1, Subscenarios A through F) as defined in Table 4-1. Figures 7-18 through 7-23 of ECF-200ZP1-16-0054 show the dilution plume from the IWs superimposed with particle track flow pathlines for release from Trenches 31 and 34 for cases A through F for Scenario 2. As in Scenario 1, the relative detectability map for Scenario 2 (Figure 6-10) shows that existing downgradient groundwater monitoring wells 299-W10-29 and 299-W10-30 intersect hypothetical releases from the LLBG trenches in areas of higher percent distribution of particle releases. The three new downgradient groundwater monitoring wells (C9625, C9626, and C9627) proposed in Scenario 1 are also shown in Figure 6-10 with wells 299-W10-29 and 299-W10-30. As in Scenario 1, the three wells are planned to intersect and detect potential contamination along the northern and southern region of the mapped release. Along with upgradient well 299-W9-2, which is not impacted by the hypothetical release, the six-well groundwater monitoring network (not to include 299-W10-31) is proposed for detection of contamination based on Scenario 2, Subscenarios A through F. Well 299-W10-31 (from the interim status network) is not included in the final status network because it is not at the point of compliance.

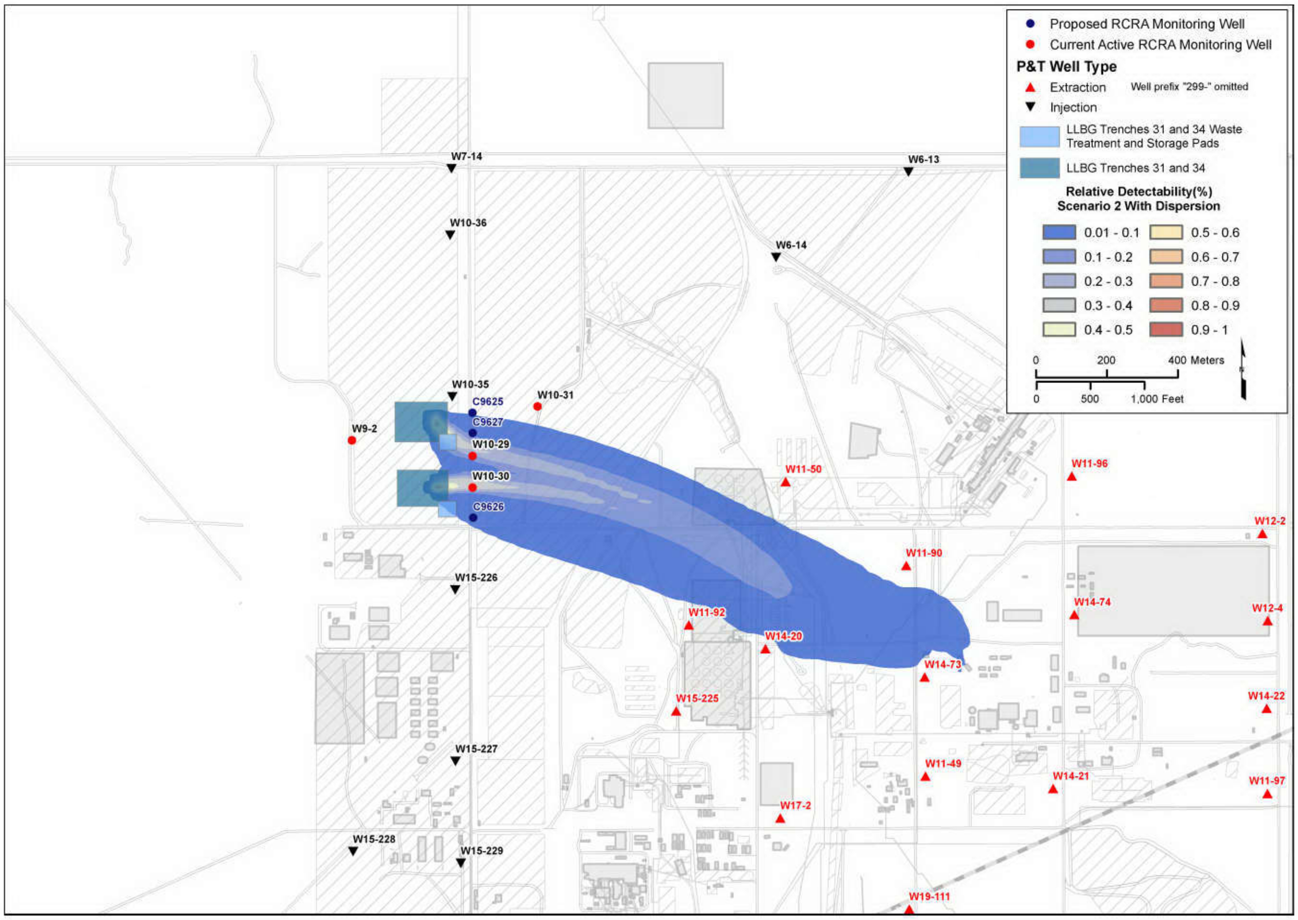

Figure 6-10. Relative Detectability of Release for Scenario 2

6.6 Scenario 3 P&T Shutdown

Following completion of the active P&T remedy, the 200 West P&T system will be shut down, and groundwater levels are expected to return to pre-remedy conditions (see Table 4-1, Scenario 3). The groundwater flow direction would primarily be towards the east to northeast. Figure 6-11 shows the hypothetical plume for releases under post-remedy conditions. Dilution would be from advection and dispersion under flow conditions without influence from the P&T remedy. Under these conditions, concentrations observed at LLBG Trench 31 and 34 monitoring wells would be approximately 40 to 53 percent of the release concentration as depicted on the release concentration curve for Scenario 3 (Figure 6-12).

The dilution map for Scenario 3 (Figure 6-11) shows that existing downgradient groundwater monitoring well 299-W10-30 intersects the hypothetical release from LLBG Trench 34 in an area of elevated contamination. The three new downgradient groundwater monitoring wells (C9625, C9626, and C9627) proposed in Scenarios 1 and 2 are also shown in Figure 6-11. The three wells are planned to intersect and detect potential contamination along the northern and southern region of the mapped release and provide earlier detection of potential releases from LLBG Trench 31 than in the existing groundwater monitoring network from well 299-W10-31. Along with upgradient well 299-W9-2, which is not impacted by the hypothetical release, groundwater monitoring wells C9625, C9627, and 299-W10-30 are proposed for detection of contamination based on Scenario 3. The relative detectability of contaminants is anticipated to be higher in these three wells based on a release in this scenario, but wells 299-W10-29 and C9626 will also be sampled.

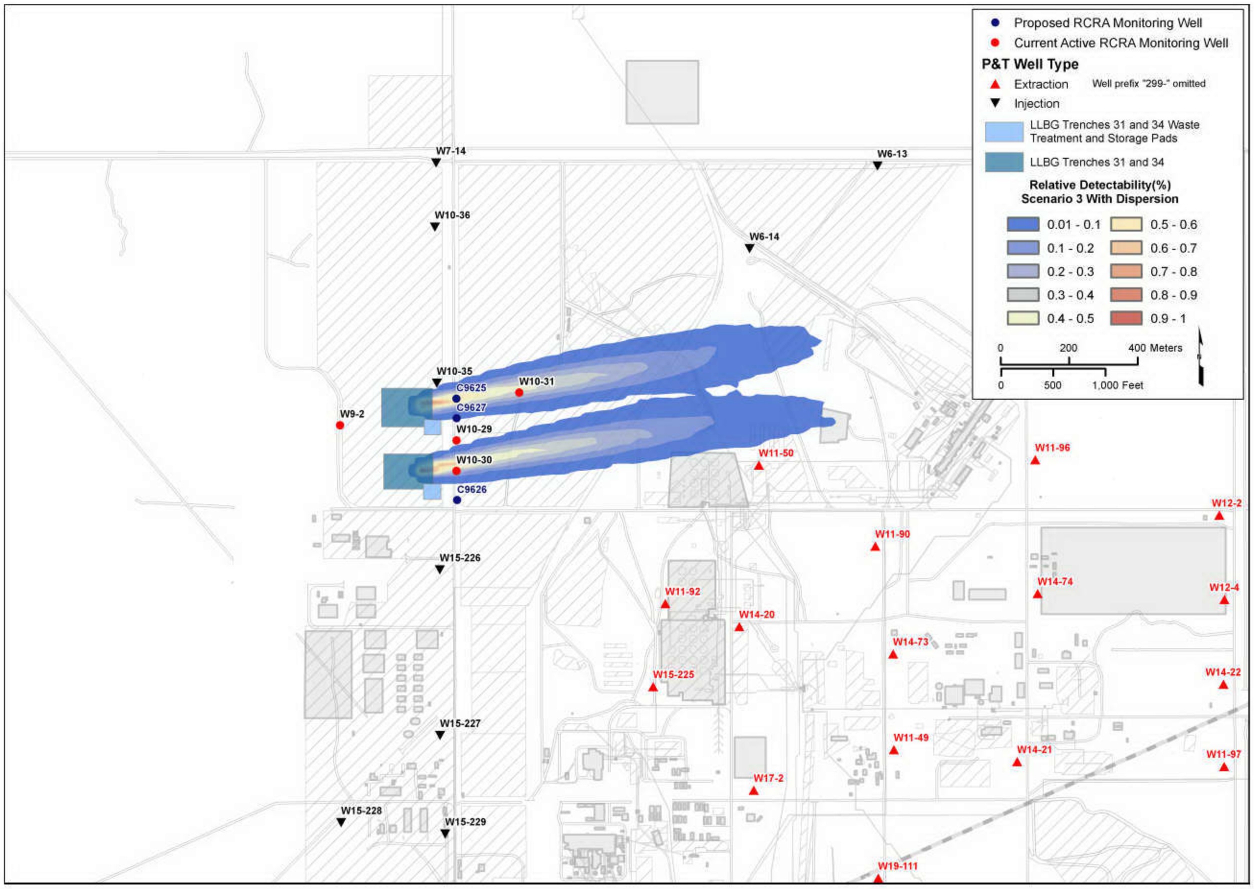

Figure 6-11. Relative Detectability of Release for Scenario 3

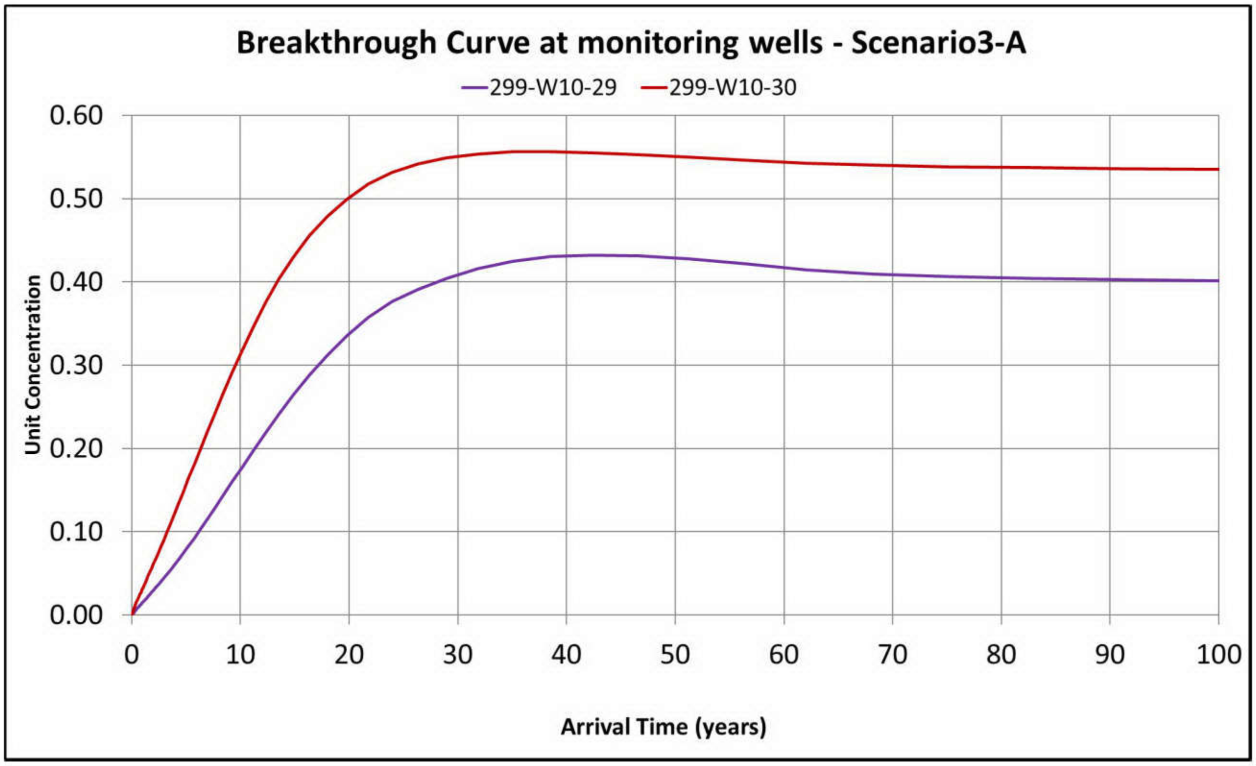

Figure 6-12. Scenario 3 Release Concentration Curves at Monitoring Wells 299-W10-30 and 299-W10-29

6.7 Conclusions

Table 6-3 provides a comparison of the percent inventory of each indicator parameter dangerous waste constituent that would need to be released for detection above the MDL for each scenario. Except for arsenic, a release of less than 0.5 percent of the total inventory will be detectable above the MDL for each waste constituent. As discussed in Sections 6.2 and 6.4, under the most likely 200 West P&T operating pumping rates, arsenic is detectable above the MDL for releases under 2.5 percent of the arsenic inventory in the trenches for Subscenarios 1A and 2A. Table 6-3 shows that arsenic would be detectable for release of less than 2 percent of the arsenic inventory under Scenario 3. The low percentage total inventory of the indicator parameter dangerous waste constituents indicates that any significant release where contamination were to reach groundwater below LLBG Trenches 31 and 34 would be detectable at the monitoring network locations.

Table 6-3. Comparison of Waste Constituent Percent Release for Detection

Waste Description	MDL* (µg/L)	Percent of Waste Constituent Inventory to Detect at 58% - 15% Breakthrough – Scenario 1 (µg/L)	Percent of Waste Constituent Inventory to Detect at 60% - 16% Breakthrough – Scenario 2 (µg/L)	Percent of Waste Constituent Inventory to Detect at 53% - 40% Breakthrough – Scenario 3 (µg/L)
4-Methyl-2-Pentanone	0.12	0.02% - 0.06%	0.02% - 0.06%	0.02% - 0.02%
Toluene	1.1	0.11% - 0.43%	0.11% - 0.4%	0.12% - 0.16%
Benzene	0.064	0.07% - 0.27%	0.07% - 0.25%	0.08% - 0.1%
1,1,1-Trichloroethane	0.069	0.% - 0.02%	0.% - 0.02%	0.01% - 0.01%
Mercury	0.06	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.01%
Arsenic	1.2	1.16% - 4.47%	1.12% - 4.19%	1.26% - 1.68%
Cadmium	0.1	0.01% - 0.04%	0.01% - 0.04%	0.01% - 0.01%
Dichloromethane	0.21	0.02% - 0.06%	0.02% - 0.06%	0.02% - 0.02%

* As reported in laboratory analysis from Test America St. Louis.

MDL = method detection limit

The proposed groundwater monitoring network for LLBG Trenches 31and 34 is located based on the simulation scenarios presented in this section and with consideration of the site infrastructure. The simulations indicate that five downgradient groundwater monitoring wells (299-W10-29, 299-W10-30, C9625, C9626, and C9627) in conjunction with an upgradient well (299-W9-2), as shown in Figures 6-5, 6-10, and 6-11, should collectively be sufficient for detection of a LLBG release under the scenarios presented. Placement of the wells takes into consideration physical constraints for well installation locations. Locating wells closer to the boundary edge of LLBG Trenches 31 and 34 is not practical because of the presence overhead power lines, equipment (i.e., leachate collection system), and roads. As such, all wells proposed in the final status network are as close to LLBG Trenches 31 and 34 waste management area boundary (200-W-254) source as practical. Additional discussion regarding each well is provided in Section 7.2.

7 Groundwater Monitoring Plan

WAC 173-303-806(4)(xx)(E) requires detailed plans and an engineering report describing the proposed monitoring program to meet the requirements of WAC 173-303-645(8) general groundwater monitoring requirements. This section describes the proposed final status detection-level groundwater monitoring program and addresses the requirements of WAC 173-303-645(8). As such, this section includes a description of the proposed groundwater monitoring network and identifies the constituents to be sampled and analyzed (i.e., dangerous waste constituents, groundwater quality, and field parameters), the sample frequency, and the sampling and analysis protocols. A detailed plan of monitoring will be specified in a separate groundwater monitoring plan and included in the Part B application with this engineering report as required by WAC 173-303-806(4)(xx)(E).

According to WAC 173-303-645(8)(a) general groundwater monitoring requirements, the groundwater monitoring system must consist of a sufficient number of wells installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that:

- Represents the quality of background groundwater that has not been affected by leakage from a regulated unit
- Represents the quality of groundwater passing the point of compliance and
- Allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer

7.1 Point of Compliance Monitoring

Collection of samples representing the quality of groundwater passing the point of compliance beneath LLBG Trenches 31 and 34 is an essential element of the final status program. The point of compliance is defined in WAC 173-303-645(6) as "…a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units." This is the location as near to the source as technically, hydrogeologically, and geographically feasible in the uppermost aquifer (WAC 173-200-060, "Water Quality Standards for Groundwaters of the State of Washington" "Point of Compliance"; WAC 173-218-030, "Underground Injection Control Program" "Definitions") where groundwater monitoring occurs and the groundwater protection standard applies. In detection monitoring, sample data from the point-of-compliance wells are evaluated against background data to determine if there is statistically significant evidence of contamination.

The 2015 groundwater map, in part, and various map simulations in Chapter 6 show that wells 299-W10-29, 299-W10-30, C9625, and C9627 are located hydraulically downgradient of LLBG Trenches 31 and 34. Well C9626 is also hydraulically downgradient of the LLBG when groundwater flow direction is to the southeast based on the model simulations. When constructed, the screen intervals in each well shall intersect the uppermost aquifer underlying the regulated units and well construction shall comply with the WAC. These features of the network satisfy most of the requirements for monitoring at the point of compliance, except the proposed well locations are not at a vertical surface located at the waste management area boundary. The wells proposed in this report for point of compliance monitoring are up to 50 m (164 ft) from the waste management area boundary.

Selection of monitoring well locations near the waste management area boundary is necessary because of the site configuration adjacent to the east side of the LLBG. Along the east and downgradient side of the LLBG, the proposed downgradient wells cannot be positioned at "a vertical surface at the limits of the waste management area" because of the presence overhead power lines, equipment (i.e., leachate collection system), and roads. In this area of limited space along the east boundary of the waste management area, drilling is restricted mainly because of the combination of drill rig mast height (over 12 m [40 ft]) and limited approach boundary to overhead power lines and roads. This same logic and safety consideration was reflected in the selection of existing wells 299-W10-29 and 299-W10-30 in the current LLBG Trench 31 and 34 interim status network.

Along the downgradient boundary of the LLBG, the waste management area is estimated to be 14 m (45 ft) from power lines and up to 27 m (90 ft) from roads. For drilling and well construction, the combined limited approach boundary to power lines and roads precludes conduct of safe operations at the waste management area boundary. As such, the proposed well locations are as near the waste management area boundary as practical to comply with the intent of WAC 173-218-030 (i.e., technically, hydrogeologically, and geographically feasible as guided by the WAC). Additional details regarding selection of these wells are presented in Section 7.2.

7.2 Proposed Groundwater Monitoring Network

The proposed groundwater monitoring network for LLBG Trenches 31 and 34 consists of one upgradient and five downgradient wells to monitor for evidence of a potential release. The six-well groundwater monitoring network is designed to monitor groundwater under the scenarios presented in Table 4-1. The various scenarios describe baseline groundwater conditions, impacts on groundwater due to P&T operations, and conditions after shutdown of P&T. Simulations of the various scenarios are presented in Chapter 6.

Information of wells proposed in the network is summarized in Table 7-1. All network wells have or will be constructed according to WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells" (i.e., RCRA compliant). Each well is screened or will be screened when constructed in the upper unconfined aquifer and yields sufficient groundwater for representative sampling. Sections 7.2.1 through 7.2.6 provide the rational for each well selected for use in the proposed groundwater monitoring network. To date, there has not been a release from LLBG Trenches 31 and 34. As such, the groundwater and soils beneath LLBG Trenches 31 and 34 have not been impacted.

Table 7-1. Attributes for Wells in the LLBG Trenches 31 and 34 Groundwater Monitoring Network

Well Name	Completion Date	Easting[a] (m)	Northing[b] (m)	Top of Casing Elevation (m) (NAVD88)	Water Table Elevation (m) (above mean sea level)	Water Depth (m [ft] below ground surface)	Depth of Water in Screen (m [ft])	Water-Level Date
299-W9-2	9/22/2011	565742.21	136872.84	223.77	137.0	87.6 (287.4)	9.8 (32.2)	03/13/2015
299-W10-29	3/13/2006	566082.98	136828.74	212.37	136.8	75.6 (248.0)	9.8 (32.2)	03/13/2015
299-W10-30	4/3/2006	566082.78	136739.33	211.65	136.8	74.9 (245.6)	9.7 (31.8)	03/13/2015
C9625	TBD	566082[a]	136951[a]	TBD	TBD	TBD	10.7 (35)	TBD
C9626	TBD	566084[a]	136654[a]	TBD	TBD	TBD	10.7 (35)	TBD
C9627	TBD	566083[a]	136893[a]	TBD	TBD	TBD	10.7 (35)	TBD

Reference: NAVD88, *North American Vertical Datum of 1988*.

a. Coordinates are approximate pending approval of proposed locations.

b. Coordinates are in Washington State Plane (south zone), NAD83, *North American Datum of 1983*; 1991 adjustment.

TBD = To be determined. Information will be obtained after well construction.

7.2.1 Groundwater Monitoring Well 299-W9-2

Groundwater monitoring well 299-W9-2 is located approximately 105 m (345 ft) upgradient of LLBG Trenches 31 and 34 at its closest approach and 5 m (17 ft) from the waste management area boundary. Constructed in 2011, this RCRA-compliant well is screened across the upper 9.8 m (32.2 ft) of the unconfined aquifer and currently yields sufficient groundwater for representative sampling. Groundwater flow direction in 2015 was to the east-northeast towards LLBG Trenches 31 and 34 (Figure 2-7) at this well. Future groundwater flow direction may be impacted by ongoing 200 West P&T operations. Simulation scenarios of groundwater flow based on various rates of pumping and injection and post-P&T operations were considered in the selection of this well for upgradient monitoring. The simulations show that potential releases from LLBG Trenches 31 and 34 will not affect groundwater quality at well 299-W-9-2. Composite maps of the simulation scenarios are shown in Figures 6-5, 6-10, and 6-11. Groundwater monitoring well 299-W9-2 is proposed to represent the quality of background groundwater quality that will not be affected by potential release from LLBG Trenches 31 and 34. Use of this well addresses WAC 173-303-645(8)(a) and (i).

7.2.2 Groundwater Monitoring Well 299-W10-29

Downgradient groundwater monitoring well 299-W10-29 was constructed in 2006 and is a RCRA-compliant well. The well is located approximately 40 m (131 ft) downgradient of the waste management area boundary. This well is screened across the upper 9.8 m (32.2 ft) of the unconfined aquifer and yields sufficient groundwater for representative sampling. To date, groundwater samples collected from this existing well and leachate data indicate no releases from LLBG Trenches 31 and 34 to groundwater. Groundwater flow direction in 2015 was predominantly to the east at this downgradient well. However, future groundwater flow direction may be impacted by ongoing 200 West P&T operations. The simulation scenarios of groundwater flow based on various rates of pumping and injection and post-P&T operations were considered in the selection of this downgradient well for monitoring. The simulations show that the well is in the flow path of the hypothetical releases. Composite plume maps of the simulations are shown in Figures 6-5, 6-10, and 6-11. Groundwater samples from this location are proposed to represent the groundwater quality at a point of compliance. This well will also allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer. Use of this well addresses WAC 173-303-645(8)(a) and (ii) and (iii).

7.2.3 Groundwater Monitoring Well 299-W10-30

Groundwater monitoring well 299-W10-30 was constructed in 2006 and is a RCRA-compliant well. The well is located approximately 40 m (131 ft) downgradient of the waste management area boundary. The well is screened across the upper 9.7 m (31.8 ft) of the unconfined aquifer and yields sufficient groundwater for representative sampling. To date, groundwater samples collected from this existing well and leachate data indicate no releases from LLBG Trenches 31 and 34 to groundwater.

Groundwater flow direction in 2015 was predominantly to the east at this downgradient well. However, future groundwater flow direction may be impacted by ongoing 200 West P&T operations. The simulation scenarios of groundwater flow based on various rates of pumping and injection and post-P&T were considered in the selection of this downgradient well for monitoring. The simulations show that the well is in the flow path of the hypothetical releases. Composite plume maps of the simulation (Scenarios 1, 2, and 3) are shown in Figures 6-5, 6-10, and 6-11. Groundwater samples from this location are proposed to represent the groundwater quality at a point of compliance. This well will also allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer. Use of this well addresses WAC 173-303-645(8)(a) and (ii) and (iii).

7.2.4 Groundwater Monitoring Well C9625

Groundwater monitoring well C9625 is a planned well and shall be constructed according to WAC 173-160. The well shall be located approximately 40 m (131 ft) downgradient of the waste management area boundary. The well shall be screened across the upper 10.7 m (35 ft) of the unconfined aquifer and yield sufficient groundwater for representative sampling when constructed.

Groundwater flow direction is predominantly to the east at this planned downgradient location. However, future groundwater flow direction may be impacted by ongoing 200 West P&T operations. The simulation scenarios of groundwater flow based on various rates of pumping and injection and post-P&T operations were considered in the selection of this downgradient well for monitoring. The simulations show that the location is in the flow path of the hypothetical releases. The simulations show that the well is in the flow path of the hypothetical releases when groundwater flow direction is to the east-northeast. A plume map representing this simulation (Scenarios 3) is shown in Figure 6-11 for the post-P&T period. Groundwater samples from this location are proposed to represent the groundwater quality at a point of compliance. This well will also allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer. Use of this well addresses WAC 173-303-645(8)(a) and (ii) and (iii).

7.2.5 Groundwater Monitoring Well C9626

Groundwater monitoring well C9626 is a planned well and shall be constructed according to WAC 173-160. The well will be screened across the upper 10.7 m (35 ft) of the unconfined aquifer and yield sufficient groundwater for representative sampling when constructed. The well will be located approximately 50 m (164 ft) southeast of the waste management area boundary.

Groundwater flow direction is predominantly to the east at this location. However, future groundwater flow direction may be impacted by ongoing 200 West P&T operations. The simulation scenarios of groundwater flow based on various rates of pumping and injection and post-P&T operation were considered in the selection of this downgradient well for monitoring. The simulations show that the location is in the flow path of the hypothetical releases. Composite plume maps of the major simulation (Scenarios 1, 2, and 3) are shown in Figures 6-5, 6-10, and 6-11. Groundwater samples from this location are proposed to represent the groundwater quality at a point of compliance when groundwater flow direction is to the southeast. This well will also allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer. Use of this well addresses WAC 173-303-645(8)(a) and (ii) and (iii).

7.2.6 Groundwater Monitoring Well C9627

Groundwater monitoring well C9627 is a planned well and shall be constructed according to WAC 173-160. The well shall be located approximately 40 m (131 ft) downgradient of the waste management area boundary. The well shall be screened across the upper 10.7 m (35 ft) of the unconfined aquifer and yield sufficient groundwater for representative sampling when constructed.

Groundwater flow direction in 2015 was predominantly to the east at this planned downgradient location. However, future groundwater flow direction may be impacted by ongoing 200 West P&T operations. The simulation scenarios of groundwater flow based on various rates of pumping and injection and post-P&T operations were considered in the selection of this downgradient well for monitoring. The simulations show that the location is in the flow path of the hypothetical releases. Composite plume maps of the major simulation (Scenarios 1, 2, and 3) are shown in Figures 6-5, 6-10, and 6-11. Groundwater samples from this location are proposed to represent the groundwater quality at a point of compliance. This well will also allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer. Use of this well addresses WAC 173-303-645(8)(a) and (ii) and (iii).

7.2.7 Summary of Groundwater Monitoring Network Design

The LLBG Trenches 31 and 34 groundwater monitoring network is designed to comply with WAC 173-303-645(8)(a) general groundwater monitoring requirements. The proposed groundwater monitoring network for LLBG Trenches 31 and 34 consists of one upgradient and five downgradient wells. The six-well groundwater monitoring network is designed to monitor up- and downgradient groundwater quality based on possible scenarios that encompass baseline groundwater conditions, impacts on groundwater due to P&T operations, and conditions after shutdown of P&T. The existing and planned wells in the network are constructed or shall be constructed in the upper unconfined aquifer according to WAC 173-160 and yield sufficient groundwater for representative sampling.

Based on current groundwater flow direction to the east and future predictions of groundwater water flow direction, the final status network wells proposed are designed to:

- Provide samples to represent the quality of background groundwater that has not been affected by leakage from the regulated unit
- Represent the quality of groundwater passing the point of compliance
- Allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer.

Data from groundwater monitoring well 299-W9-2 will be used to represent the quality of background groundwater. Groundwater monitoring wells 299-W10-29, 299-W10-30, C9625, C9626, and C9627 are positioned downgradient of the LLBGs. Water quality data from these wells represent the point of compliance and allow for detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management to the uppermost aquifer. Collectively, the five downgradient wells provide comprehensive coverage of potential release on the downgradient side of the waste management area at the point of compliance based on the simulation scenarios presented in Table 4-1.

7.3 Constituent List and Sampling Frequency

WAC 173-303-645(9)(a) requires, “monitoring for indicator parameters (e.g., pH, specific conductance, total organic carbon, total organic halogen, or heavy metals), waste constituents, or reaction products that provide a reliable indication of the presence of dangerous constituents in groundwater”. Based on the information in Chapter 3, dangerous waste constituents (arsenic, cadmium, mercury, benzene, 1,1,1-trichloroethane, 4-methyl-2-pentanone, and dichloromethane) shall be monitored at the LLBG trenches for indicators of potential releases from LLBG Trenches 31 and 34. Table 7-2 identifies all of the constituents to be analyzed for the LLBG Trench 31 and 34 groundwater monitoring network and the sampling frequency. The dangerous waste constituents shall be sampled and analyzed quarterly for the first 2 years of monitoring. After background concentrations are determined, the indicator parameter dangerous waste constituents will be sampled semi-annually. Additionally, groundwater quality parameters (alkalinity, anions, and metals) shall be sampled and analyzed annually while field measurements shall be collected each time a well is sampled. Water-level measurements at each monitoring well will be determined each time a sample is obtained (WAC 173-303-645(8)(f)). Analytical performance, data evaluation, reporting, sampling protocols, and quality assurance requirements are specified in the groundwater monitoring plan for LLBG Trenches 31 and 34.

Table 7-2. Monitoring Wells and Sample Schedule for LLBG Trenches 31 and 34

				Indicator Parameter Dangerous Waste Constituents[a]								Groundwater Quality Parameters[b]			Field Parameters[c]				
Well Name	Purpose	WAC Compliant	Water Level	Arsenic	Cadmium	Mercury	Benzene	1,1,1-Trichloroethane	4-Methyl-2-Pentanone	Dichloromethane	Toluene	Alkalinity[d]	Anions[e]	Metals[f]	pH	Specific Conductance	Dissolved Oxygen	Temperature	Turbidity
299-W9-2	Upgradient	Y	E	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	A	A	A	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA
299-W10-29	Downgradient	Y	E	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	A	A	A	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA
299-W10-30	Downgradient	Y	E	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	A	A	A	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA
C9625	Downgradient	Y	E	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	A	A	A	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA
C9626	Downgradient	Y	E	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	A	A	A	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA
C9627	Downgradient	Y	E	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA	A	A	A	Q/SA	Q/SA	Q/SA	Q/SA	Q/SA

a. Dangerous waste constituents will be monitored quarterly for the first 2 years of monitoring to determine background concentrations. After background concentrations are determined, the constituents will be monitored semi-annually.

b. Constituents are not required by RCRA but are used to support interpretation.

c. Field parameters will be measured for each sample event so field parameters will be measured quarterly for the first 2 years of monitoring and semi-annually thereafter.

d. Alkalinity includes analysis of bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity.

e. Analytes include, but are not limited to, chloride, fluoride, nitrate, nitrite, and sulfate.

f. Analysis shall be performed for filtered and unfiltered metals. Analytes include, but are not limited to, calcium, chromium, iron, magnesium, manganese, sodium, and potassium.

A = sample annually
E = each time the well is sampled
Q = sample quarterly
RCRA = *Resource Conservation and Recovery Act of 1976*
SA = sample semi-annually
Y = well is constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")

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Appendix A

Sample Results

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Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
100-02-7	P-Nitrophenol	36	14.41	0.05
10022-31-8	Barium Nitrate	1	0.40	0.64
100-37-8	2-(Diethylamino)Ethanol	1	2.63	0.01
100-41-4	Ethylbenzene	349	638.59	4.72
100-42-5	Styrene	1	2.63	0.01
10043-11-5	Boron Nitride	60	28.86	1.32
10043-35-3	Boric Acid	7	4.70	1.77
10043-52-4	Calcium Chloride	7	1.46	148.66
10045-89-3	Ferrous Ammonium Sulfate	3	2.96	0.10
100-51-6	Benzyl Alcohol	7	18.41	62.92
100-52-7	Benzaldehyde	1	3.63	0.00
10097-28-6	Silicon Oxide	1	0.21	11.90
10101-41-4	Calcium Sulfate (Plaster of Paris)	222	46.22	4,874.39
10101-89-0	Sodium Phosphate Tribasic Dodecahydrate	2	0.42	1.20
10102-06-4	Uranyl Nitrate	60	28.86	1.32
10102-45-1	Thallium(I) Nitrate	1	0.32	0.00
10124-37-5	Calcium Nitrate	4	4.25	25.91
10124-56-8	Metaphosrhoric Acid, Hexasodium Salt	1	0.21	21.50
101-55-3	Benzene, 1-Bromo-4-Phenoxy-	2	0.42	0.00
101-68-8	4,4'-Diphenylmethane-Diisocyanate	2	5.35	0.01
10294-40-3	Barium Chromate	16	47.27	159.41
103-23-1	Adipic Acid, Bis,(2-Ethylhexyl) Ester	1	3.63	0.00
10361-03-2	Sodium Metaphosphate	1	0.21	0.00
10378-23-1	Edta Acid Tetrasodium	1	3.97	0.53
10421-48-4	Ferric Nitrate (Tox Per Chemical Abstracts Service Number 7782-61-8)	2	6.35	0.00
104-76-7	2-Ethyl-1-Hexanol	1	3.63	0.00
10510-54-0	3,7-Diaminobenzo[B]Phenoxazinylium Acetate	1	2.63	0.01
10565-61-4	1-Phthalanpropylamine,6-Chloro-1-Phenyl-N,N,3,3tetramethyl,Hydrochlori	3	9.14	0.00
105-67-9	2,4-Xylenol	3	3.14	0.05
10588-01-9	Sodium Dichromate	2	6.35	0.04
10595-95-6	Ethylamine, N-Methyl-N-Nitroso-	19	3.96	0.00
106-34-3	Quinhydrone	1	2.72	0.00
106-42-3	P-Xylene	4	9.28	0.37
106-44-5	P-Cresol	662	1,126.67	28.43
106-46-7	P-Dichlorobenzene	310	886.90	8.30
106-47-8	P-Chloroaniline	2	0.42	0.00
1066-33-7	Ammonium Bicarbonate	1	0.21	21.50
106-88-7	Butane, 1,2-Epoxy – (1,2-Butylene Oxide)	4	10.61	0.46

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
107-02-8	Acrolein	1	3.63	0.00
107-06-2	1,2-Dichloroethane	285	896.42	8.32
107-12-0	Propionitrile	2	3.84	0.00
107-15-3	Ethylenediamine	2	6.35	0.01
107-20-0	Acetaldehyde, Chloro-	231	73.21	0.29
107-21-1	Ethylene Glycol	10	28.58	221.03
107-41-5	Hexylene Glycol (2-Methyl-2,4-Pentanediol)	1	3.63	0.00
107-46-0	Disiloxane, Hexamethyl	1	3.63	0.01
107-66-4	Dibutyl Phosphate	1	2.63	0.14
107-87-9	2-Pentanone	2	2.93	0.00
107-98-2	Propylene Glycol Monomethyl Ether	3	9.98	0.11
108-03-2	1-Nitropropane	1	3.63	0.00
108-05-4	Vinyl Acetate	4	13.38	0.01
108-10-1	4-Methyl-2-Pentanone	2692	4,547.27	164.99
108-24-7	Acetic Anhydride	1	2.72	0.00
108-38-3	M-Xylene	6	15.63	0.38
108-39-4	M-Cresol	696	1,143.19	29.34
108-65-6	2-Methoxy-1-Methylethyl Ester Acetic Acid	1	2.63	0.00
108-67-8	1,3,5-Trimethylbenzene	13	36.64	0.11
108-88-3	Toluene	839	1,610.40	225.24
108-90-7	Chlorobenzene	113	158.64	0.22
108-94-1	Cyclohexanone	136	415.27	5.20
108-95-2	Phenol	173	423.30	17.25
109-57-9	1-Allyl-2-Thiourea	1	0.21	0.13
109-66-0	Pentane	1	3.63	0.00
109-76-2	1,3-Propanediamine	3	9.89	0.02
109-85-3	2-Methoxyethylamine	3	9.98	0.20
109-86-4	Methoxyethanol, 2-	2	6.69	0.31
109-87-5	Dimethyoxymethane	1	2.63	0.00
109-99-9	Tetrahydrofuran	236	86.12	0.05
1103-38-4	Barium Lithol Red (Barium Not Leachable)	1	0.21	0.00
110-43-0	2-Heptanone	12	35.28	0.19
110-54-3	N-Hexane	9	27.46	1.21
110-80-5	Ethanol, 2-Ethoxy-	250	95.72	0.17
110-82-7	Cyclohexane	56	235.57	2.66
110-86-1	Pyridine	324	994.36	14.41
110-91-8	Morpholine	2	6.26	0.05
11103-86-9	Potassium Zinc Chromate	1	2.72	0.00
111-15-9	Ethanol, 2-Ethoxy-, Acetate	4	10.88	0.00
11130-12-4	Borax	1	0.21	1.00
111-40-0	Diethylenetriamine	4	12.61	0.08

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
111-44-4	Bis(2-Chloroethyl)Ether	238	75.72	5.97
111-46-6	Diethylene Glycol	3	7.98	0.91
1116-76-3	Trioctylamineine	1	2.72	0.00
111-76-2	2-Butoxyethanol	28	83.95	28.39
111-77-3	Ethanol, 2-(2-Methoxyethoxy)-	4	11.52	0.29
111-84-2	Nonane	1	3.63	0.00
111-87-5	1-Octanol	2	2.93	0.02
111-91-1	Bis(2-Chloroethoxy)Methane	2	0.42	0.00
1120-21-4	Undecane	3	9.98	0.00
112-24-3	Triethylenetetramine	2	2.66	1.55
112-27-6	Triethylene Glycol	1	2.72	0.00
112-34-5	2-(2-Butoxyethoxy)-Ethanol	5	14.33	0.04
112-57-2	1,2-Ethanediamine, N-(2-Aminoethyl)-N'-(2-((2-Aminoethyl)Amino)Ethyl)-	6	15.78	3.15
112-60-7	Tetraethylene Glycol	1	2.72	0.00
112-80-1	Oleic Acid	1	2.72	0.00
112926-00-8	Amorphous Silica, Precipitated And Gel	1	2.72	0.26
112945-52-5	Amorphous Silica	3	5.38	2.13
112-98-1	5,8,11,14,17-Pentaoxaheneicosane	1	2.72	0.00
115-10-6	Methyl Ether	6	20.89	0.07
115-40-2	Bromocresol Purple	2	0.42	0.01
115-86-6	Triphenyl Phosphate	2	2.84	2.23
117-81-7	Bis(2-Ethylhexyl)Phthalate	85	166.41	89.66
117-84-0	Di-N-Octyl Phthalate	27	64.08	17.00
118-74-1	Hexachlorobenzene	53	183.57	0.72
118-79-6	Phenol, 2,4,6-Tribromo-	28	10.10	0.00
12001-26-2	Mica Silicate	2	0.32	0.27
12001-29-5	Asbestos	25	96.12	3.63
12002-19-6	Alloy With Mercury	12	31.56	0.86
12002-48-1	Trichlorobenzene, Mixed Isomers	20	83.95	0.17
120-12-7	Anthracene	3	4.05	0.00
12018-01-8	Chromium Oxide	1	2.72	0.00
12027-67-7	Molybdic Acid, Hexaammonium Salt	1	0.21	1.06
12057-24-8	Lithium Oxide	2	0.42	0.57
120-82-1	1,2,4-Trichlorobenzene	128	299.02	1.46
120-83-2	2,4-Dichlorophenol	5	1.68	0.00
121-14-2	2,4-Dinitrotoluene	465	1,198.55	11.25
12125-02-9	Ammonium Chloride	8	20.78	0.96
121-44-8	Triethylamine	3	1.25	0.00
12168-85-3	Tricalcium Silicate	20	4.16	17.31
121-69-7	Dimethylaniline, N,N-	1	2.63	0.01

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
12173-10-3	Clinoptilolite	3	9.14	5,195.52
121888-66-2	Bentonite Clay	1	2.72	0.00
122-39-4	Diphenylamine	2	0.42	0.00
12260-45-6	Cesium Hydroxide, Hydrate	1	0.06	0.12
123-31-9	Hydroquinone	12	48.62	0.49
123-42-2	4-Hydroxy-4-Methyl-2-Pentanone	4	9.19	0.13
123-51-3	1-Butanol, 3-Methyl-	1	6.38	0.13
123-86-4	Acetic Acid, Butyl Ester	6	18.87	0.22
123-91-1	Dioxane (1,4-Diethylene Dioxide)	247	90.92	0.28
123-95-5	Butyl Stearate	1	2.72	0.00
124-17-4	Ethanol, 2-(2-Butoxyethoxy)-, Acetate	4	0.83	0.00
124-18-5	Decane	2	6.35	0.00
124-38-9	Carbon Dioxide	4	10.52	0.31
124-68-5	2-Amino-2-Methyl-1-Propanol	2	5.35	0.01
12656-85-8	Molybdate Orange	5	15.33	0.17
12672-29-6	Polychlorinated Biphenyl (Aroclor 1248)	1	2.72	0.01
126-73-8	Tributyl Phosphate (TBP)	9	24.86	1.21
126-92-1	1-Hexanol, 2-Ethyl-, Hydrogen Sulfate, Sodium Salt	1	2.72	0.00
126-98-7	2-Propenenitrile, 2-Methyl-	1	3.63	0.00
127-08-2	Acetic Acid, Potassium Salt (Potassium Acetate)	1	0.06	0.20
127087-87-0	Nonylphenol Ethoxylate (Nonionic Surfactant)	1	2.63	0.01
127-09-3	Sodium Salt Acetic Acid	4	3.34	1.76
127-18-4	Tetrachloroethylene	604	1,152.28	26.15
128-37-0	2,6-Di-Tert-Butyl-P-Cresol	6	4.09	2.47
129-00-0	Pyrene	34	8.97	0.00
1300-72-7	Sodium Xylene Sulfonate	1	2.72	0.00
1302-76-7	Aluminum Oxide Silicate (Kyanite)	1	0.21	0.98
1302-78-9	Bentonite	21	4.37	441.36
1302-93-8	Alumina Silicate (Mullite, Calcined Kyanite)	1	0.21	0.48
1303-86-2	Boric Anhydride	2	0.42	2.13
1304-28-5	Barium Oxide	2	6.69	0.28
1304-56-9	Beryllium Oxide	60	28.86	1.32
1304-76-3	Bismuth Oxide	1	0.21	0.02
1305-62-0	Calcium Hydroxide	2	0.42	0.23
1305-78-8	Calcium Oxide	6	7.23	5.39
1306-19-0	Cadmium Oxide	1	2.72	0.00
1306-38-3	Ceric Oxide	1	0.21	0.01

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
130672-62-7	Polyacrylate/Polyalcohol Copolymer	1	0.21	17.99
1307-96-6	Cobalt (2+) Oxide	2	0.42	0.02
1308-38-9	Chromic Oxide	9	26.12	1.34
1309-37-1	Ferric Oxide	5	14.56	0.25
1309-42-8	Magnesium Hydroxide	19	3.96	94.56
1309-48-4	Magnesium Oxide	5	1.04	20.45
1310-53-8	Germanium Dioxide	1	0.21	0.02
1310-58-3	Potassium Hydroxide	27	45.85	3.45
1310-65-2	Lithium Hydroxide	2	2.93	0.02
1310-66-3	Lithium Hydroxide, Monohydrate	1	0.06	0.02
13106-76-8	Ammonium Molybdate	1	3.63	0.00
1310-73-2	Sodium Hydroxide	25	75.94	130.42
131-11-3	Dimethyl Phthalate	5	1.68	0.00
1313-13-9	Manganese Dioxide	6	7.88	1.43
1313-27-5	Molybdenum Trioxide	1	0.21	0.02
1313-59-3	Sodium Oxide	3	0.62	4.24
13138-45-9	Nickel (Ii) Nitrate (1:2)	1	6.38	0.25
1313-96-8	Niobium Oxide	2	0.62	0.02
1314-13-2	Zinc Oxide	6	9.74	0.71
1314-20-1	Thorium Oxide	61	29.07	13.10
1314-23-4	Zirconium Oxide	62	29.28	2.01
1314-32-5	Thallium Oxide	1	0.21	0.00
1314-35-8	Tungsten Trioxide	2	9.00	0.04
1314-62-1	Vanadium Pentoxide (Dust) Fume Not Toxic	68	56.78	1.39
1314-80-3	Phosphorus Sulfide	2	3.14	0.00
1317-33-5	Molybdenum Disulfide	1	2.63	0.01
1317-34-6	Manganese Trioxide	1	2.63	0.00
1317-36-8	Lead Monoxide	1	2.63	0.16
1317-38-0	Copper Oxide	3	6.79	1.33
1317-61-9	Iron (Ii,Iii) Oxide	2	0.42	1.51
1317-65-3	Calcium Carbonate	4	3.16	0.26
1317-70-0	Anatase	1	3.63	0.01
1317-95-9	Silica, Crystalline – Tripoli	1	2.72	0.00
1319-77-3	Cresol	2332	4,113.21	183.03
1327-36-2	Aluminum Silicate	1	2.72	0.00
1327-53-3	Arsenic Trioxide	7	21.14	0.06
13280-61-0	P-Bis(O-Methylstyryl) Benzene	3	8.16	0.03
1328-53-6	C.I. Pigment Green 7	1	2.72	0.00
1330-20-7	Xylene (Mixed Isomers)	817	1,747.28	239.62
1330-43-4	Sodium Tetraborate	1	0.21	0.01
1332-21-4	Asbestos	259	978.75	460.85

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
1332-58-7	Kaolin Clay	3	3.04	0.73
1333-80-0	Chromic Oxide	1	2.63	0.05
1333-84-2	Activated Alumina	1	0.21	0.03
1333-86-4	Carbon Black	64	40.70	1.37
1335-30-4	Aluminum Silicate	1	2.72	0.00
1336-21-6	Ammonium Hydroxide	5	10.31	0.03
1336-36-3	Polychlorinated Biphenyls	193	441.72	1,102.30
1338-23-4	2-Butanone, Peroxide	15	28.00	0.10
134-03-2	Sodium Ascorbate	1	0.21	0.07
1344-09-8	Sodium Silicate Solution	6	14.81	1.63
1344-28-1	Aluminum Oxide	5	7.20	16.62
1344-37-2	C.I. Pigment Yellow 34	1	3.63	0.00
13463-67-7	Titanium Oxide	7	16.59	0.78
13473-90-0	Aluminum (111) Nitrate (1:3)	4	4.25	0.23
135-01-3	O-Diethylbenzene	1	2.72	0.00
13520-83-7	Uranyl Nitrate Hexahydrate	1	0.21	0.00
13548-38-4	Chromium(Iii) Nitrate	1	6.38	0.00
13573-18-7	Sodium Tripoly Phosphate	1	6.37	23.00
13590-82-4	Cerium Sulfate	1	2.72	0.00
13701-59-2	Barium Metaborate	1	2.63	0.01
13775-53-6	Sodium Hexafluoroaluminate, 98%	1	0.21	0.00
138265-88-0	Zinc Borate Hydrate	1	0.03	0.26
138-86-3	Dipentene (Limonene)	1	2.63	0.01
13907-45-4	Chromate	1	3.63	0.01
1399-57-1	Graphite	3	0.81	0.02
14018-95-2	Zinc Chromate	5	13.24	7.07
140-22-7	Diphenylcarbazide, 5,1-	1	2.63	0.01
140-31-8	1-(2-Aminoethyl) Piperazine	1	6.37	0.17
14075-53-7	Potassium Fluoborate	1	0.21	0.14
141-43-5	Ethanolamine	6	12.21	1.59
141-53-7	Sodium Formate	1	0.21	3.15
141-78-6	Ethyl Acetate	173	583.05	77.10
141-93-5	M-Diethylbenzene	1	2.72	0.00
14258-49-2	Ammonium Oxalate	2	0.42	0.38
142-82-5	Heptane	12	50.38	0.50
14302-13-7	C.I. Pigment Green 36	1	2.63	0.06
143-24-8	2,5,8,11,14-Pentoxapentadecane	1	2.72	0.00
14332-21-9	Hypoiodous Acid	60	28.86	1.32
143-33-9	Sodium Cyanide	8	21.98	0.01
144-55-8	Sodium Bicarbonate	6	6.27	1.03
144-62-7	Oxalic Acid	1	0.21	0.28

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
14464-46-1	Silica, Crystalline-Cristobalite	1	0.21	0.02
147-14-8	(Phthalocyaninto(2-)) Copper	1	2.72	0.00
14797-55-8	Nitrate	19	3.96	822.02
14807-96-6	Talc	2	5.44	0.01
14808-60-7	Crystalline Quartz Silica	27	16.66	19.59
151-21-3	Sodium Lauryl Sulfate	1	2.72	0.00
151-50-8	Potassium Cyanide	4	8.48	0.01
156-59-2	Cis-1,2-Dichloroethylene	3	9.98	0.00
16291-96-6	Charcoal	2	9.00	256.22
1634-04-4	Methyl Tert-Butyl Ether	1	0.21	2.20
1643-19-2	Tetrabutylammonium Bromide	1	3.63	0.01
16887-00-6	Chloride (Ion)	19	3.96	99.82
1694-09-3	C.I. Acid Violet 49 (Sodium Salt)	1	2.72	0.00
16984-48-8	Fluoride	2	9.10	0.00
17372-87-1	Eosine Sodium Salt	1	2.72	0.00
1762-95-4	Ammonium Thiocyanate	4	0.65	1.16
17689-77-9	Ethyltriacetoxysilane	1	0.21	0.01
18454-12-1	Lead Chromate Oxide	1	2.63	0.00
18540-29-9	Chromium (Vi)	4	15.79	0.04
191-24-2	Benzo (Ghi) Perylene	2	0.42	0.00
193-39-5	Indeno(1,2,3-Cd)Pyrene	2	0.42	0.00
20583-60-2	Rubidium Sulfate	1	0.03	0.13
205-99-2	Benz(E)Acephenanthrylene	2	0.42	0.00
206-44-0	Fluoranthene	2	0.42	0.00
20667-12-3	Silver (1+) Oxide	1	2.72	0.07
207-08-9	Benzo (K) Fluoranthene	2	0.42	0.00
208-96-8	Acenaphthylene	7	2.51	0.00
21041-95-2	Cadmium Hydroxide	1	3.62	0.16
21645-51-2	Aluminum Hydroxide	1	2.63	0.01
218-01-9	Chrysene	2	0.42	0.00
2439-89-6	Steel (Iron)	8	34.91	8,205.30
25013-16-5	Butylated Hydroxyanisole	1	2.72	0.00
25068-38-6	Bisphenol A/Epichlorohydrin Resin	7	20.01	6.11
25154-52-3	Nonyl Phenol	8	25.78	62.98
25155-30-0	Sodium Dodecylbenzenesulfonate	5	8.31	3.91
25213-39-2	2-Propenoic Acid, 2-Methylbutyl Ester Polymer W/Ethenylbenz	1	6.37	0.52
25265-77-4	2,2,4-Trimethyl-1,3-Pentanediolmonoisobutyrate	4	11.52	0.09
25322-68-3	Polyethylene Glycol	1	2.72	0.00

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25322-69-4	Polypropylene Glycols	4	11.68	0.05
25340-17-4	Diethylbenzene	1	2.72	0.03
25551-13-7	Trimethyl Benzene (Mixed Isomers)	3	9.07	0.01
25852-47-5	Polyglycol Dimethacrylate	1	2.72	0.00
260-94-6	Acridine	2	0.42	0.13
26249-20-7	Butylene Oxide	1	2.63	0.15
26761-40-0	Diisodecyl Phthalate	1	2.63	0.00
27344-41-8	Disodium 4,4'-Bis(2-Sulfostryl)Biphenyl	1	0.21	0.02
2757-28-0	Triheptylamine, 6,6',6"-Trimethyl-	1	3.63	0.00
2807-30-9	2-Propoxyethanol	1	2.72	0.01
298-00-0	O,O-Dimethyl O-P-Nitrophenyl Phosphorothioate	5	2.09	0.00
298-02-2	Phosphorodithioic Acid, O,O-Diethyl S-(Ethylthio)Methyl Ester	5	2.09	0.00
298-04-4	Disulfoton	5	2.09	0.00
298-07-7	Bis(2 Ethyl Hexyl)Hydrogen Phosphate	6	15.63	0.07
301-04-2	Lead Acetate	1	0.32	0.00
302-01-2	Hydrazine	28	121.26	3.79
31714-55-3	Organic Pigment (Chromium +Iii) Info From Mita	1	6.37	0.03
326-91-0	Thenoyltrifluoroacetone	3	9.98	0.05
3313-96-6	Sodium Carbonate	1	0.21	0.60
333-20-0	Potassium Thiocyanate	1	0.03	0.48
37205-87-1	Ethoxylated Alkylphenol	3	8.16	0.16
373-57-9	Boron Trifluoride-Methanol Complex	1	3.63	0.00
3812-32-6	Carbon Trioxide Ion(2-)	6	22.48	0.05
3844-45-9	C.I. Acid Blue 9 (Disodium Salt)	1	2.72	0.00
38640-62-9	Mixture Of Alkylnaphthalenes	3	8.16	0.44
4080-31-3	3,5,7-Triaza-1-Azoniaadamantane, 1-(3-Chloroallyl)-,Chloride	1	2.72	0.01
409-21-2	Silicon Carbide	61	31.58	1.33
4253-34-3	Methyltriacetoxysilane	2	0.42	0.09
4353-28-0	3,6,9,12,15,-Pentaoxaheptadecane	1	2.72	0.00
4477-79-6	Red Dye	2	0.06	0.00
471-34-1	Calcium Carbonate	5	5.97	1.39
4731-53-7	Tri-N-Octylphosphine	1	2.72	0.00
4792-15-8	Pentaethylene Glycol	1	2.72	0.00
496-11-7	Indan	2	6.35	0.00
496-74-2	Toluene-3,4-Dithiol	3	9.41	0.34
497-19-8	Sodium Carbonate	21	17.80	8.62

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
50-00-0	Formaldehyde	15	60.01	45.28
50-32-8	Benzo (A) Pyrene	2	0.42	0.00
506-64-9	Silver Cyanide	1	2.72	0.22
506-87-6	Ammonium Carbonate	1	0.21	0.00
507-28-8	Tetraphenylarsonium Chloride	1	3.63	0.00
50-81-7	Ascorbic Acid	2	2.93	0.01
5102-83-0	Azo Permanent Yellow	1	2.63	0.03
5124-30-1	Methylenedi-4,1-Cyclohexylene Ester Isocyanic Acid	1	2.72	0.00
51274-00-1	(C. I.) Yellow 77492	1	2.72	0.00
51-28-5	Dinitrophenol, 2,4-	80	308.07	1.63
5137-55-3	Methyltricaprylylammonium Chloride	4	12.70	0.39
526-73-8	1,2,3-Trimethylbenzene	2	6.35	0.07
5329-14-6	Sulfamic Acid	2	2.93	0.10
5332-73-0	3-Methoxypropylamine (3-Mpa)	3	9.07	0.40
534-52-1	4,6-Dinitro-O-Cresol	2	0.42	0.00
53-70-3	Dibenzanthracene, 1,2,5,6-	2	0.42	0.00
540-84-1	2,2,4-Trimethylpentane	1	3.63	0.02
541-73-1	M-Dichlorobenzene	2	0.42	0.00
544-76-3	Hexadecane	1	2.72	0.00
544-92-3	Cuprous Cyanide	3	5.76	0.00
5468-75-7	Yellow Pigment	4	0.74	0.28
55406-53-6	Carbamic Acid, Butyl-3-Iodo-2-Propynyl Ester	1	2.63	0.00
554-13-2	Lithium Carbonate	1	0.21	0.02
556-67-2	Octamethyl Cyclotetrasiloxane	1	0.21	0.06
557-34-6	Zinc Acetate	1	0.21	0.01
56-23-5	Carbon Tetrachloride	841	1,533.81	348.22
5625-37-6	1,4-Piperazinebiz (Ethanesulfonic Acid)	2	0.42	0.00
56-38-2	Parathion	2	0.83	0.00
56-49-5	3-Methylchloranthrene	1	2.72	0.00
56-55-3	Benz(A)Anthracene	2	0.42	0.00
569-61-9	Pararosanilin Hydrochloride	1	0.21	0.00
57-12-5	Cyanide	61	185.53	0.82
57-13-6	Urea	1	0.06	5.13
57-55-6	1,2-Propanediol	1	0.06	0.20
577-11-7	Dioctyl Sodium Sulfosuccinate	2	5.44	0.00
57-74-9	Chlordane	28	87.06	0.41
584-08-7	Potassium Carbonate	5	1.04	4.55
58-89-9	Lindane (Hexachlorocyclohexane)	17	7.08	0.00

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
591-78-6	Methyl Butyl Ketone	4	9.28	0.00
59473-04-0	Total Organic Halides	2	6.35	0.19
59-50-7	4-Chloro-M-Cresol	34	8.97	0.00
5972-73-6	Ammonium Oxalate Monohydrate	1	0.21	0.02
5989-27-5	D-Limonene	3	11.72	1.09
60-00-4	Edta (Ethylenediaminetetraacetic Acid)	1	0.21	0.00
60-29-7	Diethyl Ether	384	581.51	18.75
6035-94-5	Pararosaniline Acetate	1	0.21	0.00
606-20-2	2,6-Dinitrotoluene	3	2.97	0.00
60676-86-0	Crystalline-Fused Silica	2	3.84	1.74
608-93-5	Pentachlorobenzene	3	11.82	0.00
611-14-3	O-Ethyltoluene	2	6.35	0.04
6131-90-4	Sodium Acetate	1	0.21	0.11
613-48-9	N,N-Dialkyltoluidines	1	2.72	0.00
61788-76-9	Chlorinated Paraffin	1	2.72	0.00
61790-51-0	Resins	1	2.63	0.66
61790-53-2	Diatomaceous Earth	1	2.63	0.01
621-64-7	N-Nitrosodipropylamine	15	5.02	0.00
622-96-8	P-Ethyltoluene	2	6.35	0.01
62-75-9	Dimethyl Nitrosamine	18	7.29	0.00
62-76-0	Ethanedioic Acid, Disodium Salt (Sodium Oxalate)	1	0.21	0.01
630-20-6	1,1,1,2-Tetrachloroethane	67	13.94	0.00
63148-57-2	Polysiloxane, Dimethyl-	2	0.32	0.26
63148-62-9	Methylpolysiloxane	2	2.93	0.34
631-61-8	Ammonium Acetate	2	6.26	0.01
63181-94-2	Benzene, Diethenyl-, Polymer With Arethenyl-N-(2-Hydroxyethyl)-N,N-Dim	1	2.72	0.00
63449-39-8	Paraffin Waxes And Hydrocarbon Waxes, Chlorinated	2	6.35	0.02
6358-31-2	C.I. Pigment Yellow 74	1	2.72	0.00
64-17-5	Ethanol	8	20.89	0.57
64-18-6	Formic Acid	13	38.68	0.41
64-19-7	Acetic Acid	5	9.49	0.14
64365-11-3	Activated Charcoal	5	10.73	105.70
64475-85-0	Petroleum Spirits	1	2.63	0.27
646-06-0	1,3-Dioxolane	2	2.69	0.03
64741-88-4	Mineral Oil, Petroleum Distillates (Mild & Severe)	2	5.27	8.44
64741-89-5	Mineral Oil, Petroleum Dist. (Mild & Severe)	1	2.55	8.44

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
64741-96-4	Solvent – Refined (Mild-Severe) Heavy Naphthenic Mineral Oil	2	5.27	8.44
64741-97-5	Lubricating Oil Base Stock	3	7.90	8.61
64742-01-4	Solvent Refined Residuum	1	2.55	8.44
64742-11-6	Mineral Oil, Pet. Extracts, Hvy Naphthenic Dist. Solvent	1	2.63	0.02
64742-38-7	Normal Paraffins	1	3.63	0.00
64742-41-2	Clay-Treated Residual Oils (Petroleum)	1	2.63	0.39
64742-46-7	Mineral Seal Oil	6	4.09	1,238.35
64742-48-9	Hydrotreated Heavy Naphtha	5	15.42	0.10
64742-52-5	Petroleum Distillate Hydrotreated (Mild-Severe) Mineral Oil	3	11.55	10.20
64742-53-6	Hydrotreated (Mild & Severe) Light Naphthenic Distillate	8	13.01	627.65
64742-54-7	Hydrotreated (Mild & Severe) Heavy Paraffinic Distillate	1	2.55	8.44
64742-56-9	Solvent-Dewaxed (Mild & Severe) Light Paraffinic Distillate	1	2.55	5.25
64742-62-7	Solvent-Dewaxed Petroleum Residual Oils	1	2.55	8.44
64742-65-0	Solvent-Dewaxed (Mild & Severe) Heavy Paraffinic Distillate	1	2.55	8.44
64742-88-7	Medium Aliphatic Solvent Naphtha	2	6.35	0.01
64742-88-8	Aliphatic Petroleum Distillate	1	2.63	0.42
64742-89-8	Naphtha	4	11.61	0.17
64742-95-6	High Flash Aromatic Naphtha	5	15.33	0.41
6484-52-2	Ammonium Nitrate	3	4.05	0.24
65-85-0	Benzoic Acid	1	3.63	0.00
65997-15-1	Portland Cement	22	4.58	3,522.39
66402-68-4	Clay, Silicas, Talc	1	2.63	0.01
67-52-7	Barbituric Acid	3	8.16	0.07
67-56-1	Methanol	714	1,376.11	170.77
67-63-0	Isopropyl Alcohol	12	31.70	20.19
67-64-1	Acetone	3187	5,193.18	427.16
67-66-3	Chloroform	380	1,131.40	18.79
67-72-1	Hexachloroethane	263	878.51	8.43
67762-90-7	Fumed Silica	2	0.42	10.64
68-04-2	Sodium Citrate	2	5.44	0.00
68082-29-1	Polyamide Resin	1	0.03	0.08
68-12-2	N,N-Dimethylformamide	6	18.96	0.07
68131-87-3	Styrene Butadiene Rubber Latex, Mixture, Hydrocarbon Resin	1	2.63	0.07
68240-06-2	Polymer Resin	1	2.63	0.01

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
68310-52-1	Poly[Oxy(Methyl-1,2-Ethanedeyl)],.Alpha,-Hydor-.Omega.-Hydroy-Ether	1	2.72	0.01
6834-92-0	Sodium Metasilicate	9	15.15	25.74
68410-23-1	Polyethyenepolyamine	1	2.63	1.50
68412-54-4	Nonylphenoxypolyethoxyethanol	1	2.72	0.28
68439-46-3	Linear Primary Alcohol, Ethoxylate	1	2.63	0.28
68439-57-6	Sodium Alpha-Olefin Sulfonate	1	0.32	3.00
68476-85-7	Liquefied Petroleum Gas (LPG)	2	5.26	1.24
68479-98-1	Diethyltoluenediamine	1	2.72	0.00
68515-25-3	Alkylbenzenes	1	2.72	0.00
68554-67-6	Silanol	1	0.21	0.14
68611-24-5	Magnesium Resinate	1	2.72	0.00
68611-44-9	Dichlorodimethyl Silane Reaction Products With Silica	1	0.21	0.40
68855-54-9	Diatomaceous Earth Flux Calcined	1	0.21	0.03
68909-13-7	Bastnaesite, Calcined Conc.	1	0.21	0.01
68911-87-5	Clay	1	2.63	0.00
68920-70-7	Chlorinated Paraffin	2	6.35	0.05
68952-35-2	Tar Acids, Cresylic, Phenyl, Phosphate	1	0.21	0.00
69-72-7	Salicylic Acid	1	0.21	0.07
70131-67-8	Hydroxypolydimethylsiloxane	2	0.42	1.26
70161-54-5	Acrylic Resin	1	2.63	0.02
70776-37-3	Epoxy Resin	1	2.72	0.00
71-36-3	Butyl Alcohol	663	1,305.93	36.00
71-43-2	Benzene	637	1,385.23	20.77
71-55-6	1,1,1-Trichloroethane	2817	4,693.81	334.77
72-20-8	Endrin	38	20.87	0.10
72623-83-7	Lubricating Oils	1	2.55	8.44
7429-90-5	Aluminum	122	334.27	936.39
7429-91-6	Dysprosium	61	30.68	1.32
7439-88-5	Iridium Powder	60	28.86	1.32
7439-89-6	Iron	97	51.53	1.60
7439-92-1	Lead	1577	4,118.01	469,449.00
7439-93-2	Lithium	61	30.68	1.32
7439-95-4	Magnesium	65	38.42	1.32
7439-96-5	Manganese	65	40.93	1.32
7439-97-6	Mercury	770	2,333.32	249.97
7439-98-7	Molybdenum	89	34.90	1.32
7440-02-0	Nickel	191	155.24	40.42
7440-15-5	Rhenium	1	0.21	0.00
7440-16-6	Rhodium	1	2.78	0.01

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
7440-18-8	Ruthenium	1	1.81	0.00
7440-19-9	Samarium	60	28.86	1.32
7440-20-2	Scandium	1	0.21	0.00
7440-21-3	Silicon	100	60.87	1.43
7440-22-4	Silver	656	1,697.43	108.75
7440-23-5	Sodium	89	54.89	393.49
7440-24-6	Strontium	1	1.81	0.00
7440-25-7	Tantalum	60	28.86	1.32
7440-28-0	Thallium	90	57.03	0.01
7440-29-1	Thorium	31	8.06	0.00
7440-31-5	Tin	60	28.86	1.32
7440-32-6	Titanium	93	46.67	2.04
7440-33-7	Tungsten	61	30.68	1.32
7440-36-0	Antimony	43	19.96	0.00
7440-38-2	Arsenic	491	1,431.95	23.39
7440-39-3	Barium	582	1,569.31	141.81
7440-41-7	Beryllium	370	960.68	72.54
7440-42-8	Boron	61	30.68	1.32
7440-43-9	Cadmium	750	1,962.05	222.81
7440-44-0	Carbon	63	38.18	382.85
7440-46-2	Cesium	1	0.21	0.00
7440-47-3	Chromium	972	2,524.75	216.01
7440-48-4	Cobalt	96	49.13	2.16
7440-50-8	Copper	129	213.85	475.86
7440-53-1	Europium	61	30.68	1.32
7440-54-2	Gadolinium	60	28.86	1.32
7440-55-3	Gallium	1	0.21	0.00
7440-56-4	Germanium	1	0.21	0.00
7440-58-6	Hafnium	60	28.86	1.32
7440-61-1	Uranium	34	15.59	0.00
7440-62-2	Vanadium	131	220.93	7.03
7440-65-5	Yttrium	1	0.21	0.00
7440-66-6	Zinc	80	56.64	1.89
7440-67-7	Zirconium	60	28.86	1.32
7440-69-9	Bismuth	3	2.05	5.25
7440-70-2	Calcium	65	40.02	1.32
7440-74-6	Indium	1	0.21	0.00
7447-39-4	Cupric Chloride	1	2.72	0.00
7447-40-7	Potassium Chloride	4	3.20	1.21
7447-41-8	Lithium Chloride	1	0.21	0.02
74-87-3	Chloromethane	22	15.60	0.00

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
7487-88-9	Magnesium Sulfate (Epsom Salts)	200	41.64	1,553.01
74-88-4	Iodomethane	65	30.96	1.32
75-00-3	Chloroethane	81	231.81	1.14
75-01-4	Vinyl Chloride (Chloroethylene)	302	913.51	85.70
75-05-8	Acetonitrile	2	6.35	0.09
75-07-0	Acetaldehyde	231	73.21	0.06
75-09-2	Dichloromethane	3038	5,004.20	284.00
75-15-0	Carbon Disulfide	267	88.06	1.98
75-21-8	Ethylene Oxide	3	8.47	0.02
75-34-3	1,1-Dichloroethane	8	32.15	0.24
75-35-4	1,1-Dichloroethylene	388	913.45	7.78
75-36-5	Acetyl Chloride	2	3.14	0.00
75-45-6	Chlorodifluoromethane	80	299.47	2.43
75-52-5	Nitromethane	1	2.72	0.00
7558-79-4	Sodium Phosphate Dibasic	1	0.21	0.04
75-68-3	1-Chloro-1,1-Difluoroethane	16	58.03	0.45
75-69-4	Trichlorofluoromethane	206	666.70	53.90
75-71-8	Dichlorodifluoromethane	136	467.92	5.13
75-75-2	Methanesulfonic Acid	1	2.72	0.00
7587-88-9	Magnesium Sulfate	1	0.21	28.15
7601-54-9	Sodium Phosphate, Tribasic	4	5.86	14.93
76-01-7	Pentachloroethane	69	211.32	1.15
7601-89-0	Sodium Perchlorate	1	0.21	0.00
7601-90-3	Perchloric Acid	1	2.63	0.04
76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	453	989.65	12.81
7631-86-9	Silicon Dioxide	6	6.00	6.04
7631-99-4	Sodium Nitrate	214	59.53	2,883.38
7632-00-0	Sodium Nitrite	11	10.73	1.53
7632-50-0	Ammonium Citrate	3	4.05	0.62
76-44-8	Heptachlor	66	106.57	0.52
7646-79-9	Cobalt Chloride	2	6.58	0.07
7646-85-7	Zinc Chloride (Reference Merck Index) (Ph = 2.5 Of 1:1 soln)	18	48.59	0.40
7647-01-0	Hydrochloric Acid	6	18.14	0.04
7647-14-5	Sodium Chloride	275	69.21	3,719.65
7647-17-8	Cesium Chloride	2	0.56	0.84
76-61-9	Thymol Blue	1	0.21	0.00
7664-38-2	Phosphoric Acid	4	9.28	0.02
7664-39-3	Hydrofluoric Acid	7	28.52	1.28
7664-41-7	Ammonia	5	10.82	0.01
7664-93-9	Sulfuric Acid	6	20.69	0.23

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
76774-25-9	Sodium Polyacrylate	1	0.03	0.19
7681-11-0	Potassium Iodide	1	2.72	0.00
7681-38-1	Sodium Bisulfate	2	0.42	0.01
7681-49-4	Sodium Fluoride	11	9.56	7.05
7681-52-9	Sodium Hypochlorite	2	0.42	0.11
7681-82-5	Sodium Iodide	2	0.24	0.33
7697-37-2	Nitric Acid	70	54.30	2.97
7704-34-9	Sulfur	60	28.86	1.32
7704-99-6	Zirconium Hydride	60	28.86	1.32
7720-78-7	Ferrous Sulfate	3	0.62	0.01
7722-64-7	Potassium Permanganate	2	4.18	0.54
7722-76-1	Ammonium Dihydrogen Phosphate	3	0.53	5.60
7722-84-1	Hydrogen Peroxide	5	8.58	0.08
7722-88-5	Tetrasodium Pyrophosphate (TSPP)	1	2.72	0.00
7723-14-0	Phosphorus (Red, White/Yellow, Black/Violet)	63	31.09	1.32
7727-21-1	Potassium Persulfate	1	0.21	0.08
7727-43-7	Barium Sulfate	3	5.56	0.02
7732-18-5	Water	30	55.60	678.70
77-47-4	Hexachlorocyclopentadiene	2	0.42	0.00
7757-79-1	Potassium Nitrate	4	5.86	0.07
7757-82-6	Sodium Sulfate	299	72.21	7,510.66
7757-83-7	Sodium Sulfite	2	0.24	4.65
7758-29-4	Sodium Tripoly/Phosphate	1	0.21	0.01
77-58-7	Dibutylbis(Lauroyloxy)Stannane	1	2.72	0.00
7758-89-6	Cuprous Chloride	1	0.21	0.39
7758-95-4	Lead Chloride (Pb = 74.5% Wt.)	1	2.72	0.02
7758-97-6	Lead Chromate	7	20.51	1.13
7758-98-7	Cupric Sulfate	3	0.45	2.32
7761-88-8	Silver Nitrate	1	2.63	0.03
7775-14-6	Dithionous Acid, Disodium Salt	2	0.42	0.00
7775-27-1	Peroxydisulfuric Acid, Disodium Salt	2	5.44	0.02
7778-18-9	Calcium Salt Sulfuric Acid	4	6.99	5.08
7778-77-0	Potassium Phosphate Monobasic	4	10.88	0.03
7778-80-5	Potassium Sulfate (2:1)	199	46.45	207.15
7782-42-5	Graphite	63	36.75	1.38
7782-49-2	Selenium	444	1,474.89	14.55
7782-63-0	Iron Sulfate Heptahydrate	1	0.21	0.07
7783-00-8	Selenious Acid	1	6.38	0.02
7783-20-2	Ammonium Sulfate	270	55.94	26,446.71
7783-28-0	Ammonium Phosphate Dibasic	2	5.44	0.00

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Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
7784-30-7	Aluminum Phosphate Monobasic (1:1)	1	2.63	0.08
7786-30-3	Magnesium Chloride	3	2.99	0.27
7789-00-6	Potassium Chromate	1	3.63	0.00
7789-23-3	Potassium Fluoride	3	4.05	0.36
7789-29-9	Potassium Bifluoride	1	0.21	0.27
7789-41-5	Calcium Bromide	1	0.21	0.00
7789-75-5	Calcium Fluoride	6	14.81	4.71
7791-13-1	Cobalt Chloride Hexahydrate	2	0.24	0.47
7791-18-6	Magnesium Chloride, Hexahydrate	1	2.72	0.00
77-92-9	Citric Acid	2	6.59	6.14
7803-55-6	Ammonium Vanadate	5	9.02	0.00
78-83-1	Isobutyl Alcohol	8	21.96	1.33
78-92-2	Sec-Butyl Alcohol (Butanol)	4	11.61	0.03
78-93-3	Methyl Ethyl Ketone	3252	5,104.68	463.19
79-00-5	1,1,2-Trichloroethane	129	76.65	2.56
79-01-6	Trichloroethylene	639	1,121.21	26.88
79-09-4	Propionic Acid	1	3.63	0.00
79-10-7	Acrylic Acid	1	0.03	0.00
79-11-8	Chloroacetic Acid	4	10.88	0.00
79-24-3	Nitroethane	1	3.63	0.00
79-27-6	Tetrabromoethane, 1,1,2,2-	6	15.76	1.39
79-34-5	1,1,2,2-Tetrachloroethane	26	110.33	0.60
8001-58-9	Coal Tar Creosote	1	2.63	2.00
8006-28-8	Soda Lime	1	2.63	0.04
8006-54-0	Lanolin	1	2.72	0.00
8006-61-9	Gasoline	3	8.16	0.00
8008-20-6	Kerosene	8	25.40	4.09
80-11-5	N-Methyl-N-Nitroso-P-Toluenesulfonamide	1	0.03	0.14
8012-95-1	Mineral Oil	1	2.63	0.08
80-15-9	Cumene Hydroperoxide	2	2.93	0.27
8016-28-2	Animal Fatty Oil	1	0.06	0.00
8021-39-4	Creosote, Wood	1	3.97	13.50
8030-30-6	Benzin	2	6.35	0.01
8031-18-3	Atlapulgite Clay	3	0.53	0.47
8032-32-4	Ligroine	3	9.98	0.03
8052-41-3	Stoddard Solvent	6	18.05	0.36
8052-42-4	Asphalt	1	3.63	0.16
80-62-6	Methyl Ester Methacrylic Acid	8	13.91	0.00
81-07-2	1,1-Dioxide-1,2-Benzisothiazolin-3-One	1	2.72	0.00
81133-20-2	Ascarite	1	0.21	0.29
83-32-9	Acenaphthene	53	16.88	0.00

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
84-66-2	Diethyl Phthalate	2	0.42	0.00
84-74-2	Dibutyl Phthalate	50	36.28	0.40
84852-15-3	Phenol, 4-Nonyl-, Branched	1	2.63	0.00
85-01-8	Phenanthrene	10	9.53	0.00
85-68-7	Benzyl Butyl Ester Phthalic Acid	8	5.14	0.00
86508-42-1	Perfluoro Compounds	1	2.72	0.07
86-73-7	Fluorene	7	1.46	0.00
872-50-4	Methyl-2-Pyrrolidinone, 1-	5	18.07	0.02
87-61-6	1,2,3-Trichlorobenzene	1	3.63	0.00
87-68-3	Hexachlorobutadiene	107	230.55	0.75
87-86-5	Pentachlorophenol	301	894.34	13.51
87-90-1	S-Triazine-2,4,6(1h,3h,5h)-Trione, 1,3,5-Trichloro-	1	3.97	0.03
88-06-2	2,4,6-Trichlorophenol	32	115.22	0.61
88-74-4	2-Nitroaniline	2	0.42	0.00
88-75-5	O-Nitrophenol	2	0.42	0.00
88-99-3	Phthalic Acid	2	6.35	0.00
9002-86-2	Polyvinyl Chloride (Pvc)	2	5.26	11.19
9003-13-8	Polypropylene Glycol Monobutyl Ether	1	2.72	0.05
9003-22-9	Vinyl Acetate-Vinyl Chloride Copolymer	2	7.26	0.02
9003-29-6	Polybutenes	1	3.63	0.20
9003-55-8	Styrene Polymer With 1,3-Butadiene	2	9.00	0.09
9004-70-0	Nitrocellulose	6	20.89	0.32
9004-82-4	Sodium Laureth Sulfate	1	0.32	2.70
9004-96-0	Polyglycol Oleate	1	2.72	0.00
9010-76-8	Copolymer Resin	1	2.63	0.14
9010-98-4	2-Chloro-1,3-Butadiene Polymers	1	2.72	0.00
90-13-1	1-Chloronaphthalene	3	2.78	0.00
9016-45-9	Nonylphenoxypoly (Ethyleneoxy) Ethanol	3	5.56	2.28
9036-19-5	Polyoxyethylene Monooctylphenl Ether	1	3.63	0.01
9046-10-0	Jeffamine D-230	2	5.26	0.00
90-72-2	Phenol, 2,4,6-Tris(Dimethylaminomethyl)-	2	9.00	0.01
91-20-3	Naphthalene	67	53.20	0.16
91-58-7	2-Chloronaphthalene	2	0.42	0.00
92-71-7	2,5-Diphenyloxazole	5	14.51	0.05
93-72-1	2,4,5-TP Silvex	19	3.96	0.00
93-76-5	2,4,5-T	8	2.52	0.00
94-36-0	Benzoyl Peroxide	1	0.21	0.00
94-75-7	2,4-Dichlorophenoxy Acetic Acid	65	13.52	0.00
95-47-6	O-Xylene	6	18.14	0.08
95-48-7	O-Cresol	657	1,066.95	20.79

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
95-50-1	O-Dichlorobenzene	6	4.39	0.00
95-57-8	2-Chlorophenol	36	15.15	0.00
95-63-6	1,2,4-Trimethylbenzene	31	123.11	9.59
95-95-4	2,4,5-Trichlorophenol	58	81.95	2.03
96-29-7	2-Butanone, Oxime	1	3.63	0.00
96-37-7	Methylcyclopentane	1	2.72	0.00
97-84-7	N,N,N',N'-Tetramethyl-1,3-Butanediamine	3	9.89	0.04
97-85-8	Isobutyric Acid, Isobutyl Ester	1	3.63	0.01
98-00-0	Furfuryl Alcohol	1	2.63	0.00
98-06-6	Tert-Butylbenzene	2	5.44	0.02
98-86-2	Acetophenone	2	6.57	0.59
98-95-3	Nitrobenzene	321	891.83	8.33
99-76-3	Methyl P Hydroxybenzoate	1	2.72	0.00
GCN001	Remainder Non-Hazardous per the Manufacturer	6	1.10	32.85
GCN011	Acyrlic Resins	2	0.62	1.37
GCN018	Paraffinic Hydrocarbons	1	2.72	0.00
GCN019	Fragrance	1	0.21	0.11
GCN020	Surfactants	1	0.21	0.07
GCN025	Dye	1	0.21	0.00
GCN026	Soap/Detergent	1	0.21	0.01
GCN030	Fillers	1	0.21	0.32
GCN031	Additives (Non-Specified)	1	0.21	0.16
GCN035	Waxes (Non-Specified)	1	0.21	9.60
GCN042	Polyurethane (Non-Specified)	2	47.50	185.80
GCN045	Vinyl Acrylic Latex	1	0.21	0.50
GCN046	Glycols, Colors	1	0.21	0.11
GCN047	Tinting Materials (Non-Specified)	1	0.06	0.20
GCN049	Absorbents (Non-Specified)	36	31.16	1479.95
GCN052	Soils/Slurries From Well Drillings	4	0.83	254.30
GCN055	Inert Material (Paper, Wood, Plastic, etc.)	787	1,650.79	825,401.14
GCN056	Inert Non-Hazardous Material	19	39.88	14,945.04
GCN060	Anion/Cation Exchange Resin	2	0.42	0.12
GCN062	Polymers (Non-Specified)	1	6.37	100.00
GCN064	Chlorinated Aromatic Hydrocarbon – Organic Halides	1	2.63	0.00
GCN067	Fiber Glass	2	47.50	103.69
GCN089	Zinc Compounds (Non Specific)	1	0.21	0.90
GCN096	Catalyst (Non-Specified)	1	0.06	0.20
GCN109	Resins (Non-Specified)	2	0.53	87.01

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
GCN115	Metal Compound, Non-Regulated (Non-Specified)	61	29.07	139.71
GCN118	Silicones (Emulsified)	1	0.21	0.07
GCN121	Total Product Toxic D Per Manufacturer	1	0.32	12.00
GCN127	Sulfates (Non-Specified)	9	1.99	0.15
GCN3901	Liquids, Unspecified	1	0.32	0.58
GCNABSM	Absorbent, Mineral	21	4.40	400.67
GCNABSO	Absorbent, Organic	26	85.93	148.83
GCNABSOIL	Absorbed Oil	8	2.35	579.21
GCNABSSLUDG	Absorbed Sludge	1	0.21	7.32
GCNABSWATER	Absorbed Water	12	7.74	2,825.56
GCNALMMER	Amalgamated Mercury	25	5.20	2,131.70
GCNANIMAL	Animal Carcasses	1	0.21	0.04
GCNANIMALW	Animal Waste/Bedding	5	1.15	1.40
GCNASBESTOS	Asbestos	169	533.84	1,543.74
GCNASH	Ash	173	47.53	24,357.78
GCNASPHALT	Asphalt	16	28.12	8,455.27
GCNBALLAST	PCB Contaminated Ballasts, Leaking	1	0.21	6.60
GCNBALLASTN	PCB Contaminated Ballasts, Nonleaking	3	15.48	9.08
GCNBRICK	Brick, Fire Brick,etc.	1	0.21	1.41
GCNCAPACITOR	PCB Contaminated Capacitors	1	0.21	24.00
GCNCLOTH	Cloth	34	97.97	522.23
GCNCONCAR	Grouted Activated Carbon	6	1.27	512.00
GCNCONCRETE	Concrete/Grout	76	95.92	46,110.45
GCNDEBRIS	Misc. Compactible Debris (Paper, Plastic, Metal, Wood, etc.)	765	2,755.52	961,955.97
GCNFGLASS	Fiberglass	2	11.27	54.85
GCNGLASS	Glass	43	67.84	7,254.74
GCNHEPA	HEPA Filters	3	7.89	398.26
GCNINORGDEBR	Inorganic Debris (Mixed Inorganic/Metal, Concrete, Glass)	2	0.42	2.60
GCNKSLUDG	K-Basins Sludge	1	0.21	0.00
GCNLABPACK	Labpack	7	1.46	39.19
GCNMETAL	Metal (Nonhazardous)	313	782.90	124,701.17
GCNNONHAZ	Solid Non-Haz Components (Non-Specified)	312	108.82	692.13
GCNNONHAZABS	Absorbed Nonhazardous Liquid (Nonspecified)	1	0.42	6.34
GCNNONHAZLIQ	Liquid Non-Haz Components (Non-Specified)	2	0.42	28.02
GCNOIL	Oil (Non-Specified, No Cas#)	2	2.76	15.38

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
GCNORGDEBRIS	Organic Debris (Mixed Organic/ Incidental Inorg)	8	65.19	2,122.88
GCNPAPER	Paper/Cardboard	41	92.22	610.53
GCNPCBC	PCB Contaminated PPE, Clothing, Rags, Inerts	2	7.51	20.57
GCNPLASTIC	Plastic	161	382.53	46,348.43
GCNPPE	PPE Clothing (Gloves, Tyveks, Swps, Disposables)	1	0.21	6.46
GCNREGTANK WA	Regulated Tank Waste Material	84	17.80	494.89
GCNRUBBER	Rubber	23	143.84	781.60
GCNSAND	Sand	12	7.66	3,655.88
GCNSOIL	Soil/Rock/Gravel	896	310.96	209,040.75
GCNSOLINOG	Solidified Inorganic Sludge Or Liquid	1	0.21	1.58
GCNSOLORG	Solidified Organic Sludge Or Liquid	1	0.21	71.65
GCNSTABIN	Stabilized Inert Material (LDR Compliant)	88	91.63	24,731.96
GCNSTABRES	Stabilized Thermal Treatment Residue	160	41.45	25,314.52
GCNSTBSLUDG	Stablized Sludge	8	34.78	2,714.77
GCNTANKSO	Tank Solids And Scale (Non-Regulated)	1	0.21	0.00
GCNTHERRES	Thermal Treatment Residue	211	70.17	43,961.54
GCNVEGE	Vegetation	22	10.85	124.69
GCNVIT	Thermal Treatment Glass and Secondary Solids	7	11.48	5,661.84
GCNWOOD	Wood	118	424.84	69,299.13
GCNWRPCLAM	WRP Clamshell	3	0.97	8.16
GCNWRPCRIB	WRP Blocking & Bracing	52	16.74	11.96
GCNWRPMETAL	WRP Inner Container – Waste Metal	52	16.74	1,406.00
TEMP2182	Mercury Amalgam	1	0.21	4.40
TEMP3731	Thinner 10 (Methyl Isobutyl Ketone, Toluene, Xylene, VM & P Naphtha)	116	24.15	0.15
7440-09-7	Potassium	85	44.19	44.59
9003-04-7	Sodium Polyacrylate	1	23.75	69.37
7783-03-1	Tungstic Acid	1	0.21	0.02
7791-11-9	Rubidium Chloride	1	0.21	0.02
5470-11-1	Hydroxylamine Hydrochloride	5	3.37	4.41
7758-11-4	Potassium Phosphate Dibasic	1	0.21	0.05
9003-01-4	Acrylic Acid, Polymers (Resin)	3	5.76	110.94
7758-02-3	Potassium Bromide	1	0.21	0.74
2474-02-4	Dichlorooctamethyltera Siloxane	1	2.72	0.00
7446-09-5	Sulfur Dioxide	2	6.35	0.01
8009-03-8	Petrolatum	2	9.09	0.03

Table A-1. Waste Constituent Inventory in Trenches 31 and 34

Chemical Abstracts Service Number	Waste Constituent	Count of Packages Containing Constituent	Sum Volume of Containers with Constituent (m^3)	Total Waste Weight of Constituent (kg)
8002-05-9	Petroleum Distillates	1	3.63	0.01
4719-04-4	Hexahydrohydroxyethyltriazine	1	2.72	0.00
5819-01-2	Selenide-Organic	1	2.72	0.00
7446-11-9	Sulfur Trioxide	1	2.72	0.01
7775-11-3	Sodium Chromate	1	2.72	0.00
9003-11-6	Polyoxpropylene-Polyoxethylene	2	5.44	0.05

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DY21	71-55-6	1,1,1-Trichloroethane	1	µg/L	U
B1DY21	79-00-5	1,1,2-Trichloroethane	1	µg/L	U
B1DY21	75-34-3	1,1-Dichloroethane	1	µg/L	U
B1DY21	75-35-4	1,1-Dichloroethene	1	µg/L	U
B1DY21	120-82-1	1,2,4-Trichlorobenzene	1.8	µg/L	U
B1DY21	107-06-2	1,2-Dichloroethane	1	µg/L	U
B1DY21	540-59-0	1,2-Dichloroethene (Total)	1	µg/L	U
B1DY21	106-46-7	1,4-Dichlorobenzene	1	µg/L	U
B1DY21	106-46-7	1,4-Dichlorobenzene	1.4	µg/L	U
B1DY21	71-36-3	1-Butanol	100	µg/L	U
B1DY21	88-06-2	2,4,6-Trichlorophenol	0.51	µg/L	U
B1DY21	121-14-2	2,4-Dinitrotoluene	0.39	µg/L	U
B1DY21	78-93-3	2-Butanone	1	µg/L	U
B1DY21	111-76-2	2-Butoxyethanol	0.68	µg/L	U
B1DY21	95-57-8	2-Chlorophenol	2.2	µg/L	U
B1DY21	591-78-6	2-Hexanone	1	µg/L	U
B1DY21	95-48-7	2-Methylphenol (Cresol, *O*-)	0.26	µg/L	U
B1DY21	107-87-9	2-Pentanone	1	µg/L	U
B1DY21	65794-96-9	3+4 Methylphenol (Cresol, *M*+*P*)	0.65	µg/L	U
B1DY21	59-50-7	4-Chloro-3-Methylphenol	0.48	µg/L	U
B1DY21	106-47-8	4-Chloroaniline	0.58	µg/L	U
B1DY21	108-10-1	4-Methyl-2-Pentanone	1	µg/L	U
B1DY21	100-02-7	4-Nitrophenol	1.2	µg/L	U
B1DY21	83-32-9	Acenaphthene	2.8	µg/L	U
B1DY21	67-64-1	Acetone	1	µg/L	U
B1DY21	75-05-8	Acetonitrile	2	µg/L	U
B1DY21	98-86-2	Acetophenone	0.35	µg/L	U
B1DY21	7429-90-5	Aluminum	134	µg/L	C
B25NB6	7429-90-5	Aluminum	64	µg/L	B
B30T80	7429-90-5	Aluminum	48.8	µg/L	B
B32JY6	7429-90-5	Aluminum	25.5	µg/L	B
B1DY21	7440-36-0	Antimony	1.66	µg/L	C
B1DY21	7440-36-0	Antimony	25	µg/L	U
B25NB6	7440-36-0	Antimony	0.333	µg/L	B
B30T80	7440-36-0	Antimony	1	µg/L	U
B32JY6	7440-36-0	Antimony	1	µg/L	U
B1DY21	12674-11-2	Aroclor-1016	0.11	µg/L	U

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DY21	11104-28-2	Aroclor-1221	0.21	µg/L	U
B1DY21	11141-16-5	Aroclor-1232	0.11	µg/L	U
B1DY21	53469-21-9	Aroclor-1242	0.11	µg/L	U
B1DY21	12672-29-6	Aroclor-1248	0.11	µg/L	U
B1DY21	11097-69-1	Aroclor-1254	0.11	µg/L	U
B1DY21	11096-82-5	Aroclor-1260	0.11	µg/L	U
B1DY21	7440-38-2	Arsenic	14.1	µg/L	
B25NB6	7440-38-2	Arsenic	15.7	µg/L	
B30T80	7440-38-2	Arsenic	13.7	µg/L	
B32JY6	7440-38-2	Arsenic	13.9	µg/L	
B1DY21	7440-39-3	Barium	32	µg/L	
B25NB6	7440-39-3	Barium	61	µg/L	
B1DY21	71-43-2	Benzene	1	µg/L	U
B1DY21	100-51-6	Benzyl Alcohol	0.31	µg/L	U
B1DY21	7440-41-7	Beryllium	0.5	µg/L	U
B25NB6	7440-41-7	Beryllium	0.05	µg/L	U
B25NB6	7440-41-7	Beryllium	4	µg/L	U
B30T80	7440-41-7	Beryllium	0.2	µg/L	U
B32JY6	7440-41-7	Beryllium	0.2	µg/L	U
B1DY21	108-60-1	Bis(2-Chloro-1-Methylethyl)Ether	1.5	µg/L	U
B1DY21	24959-67-9	Bromide	0.093	mg/L	U
B25NB6	24959-67-9	Bromide	0.322	µg/mL	BD
B1DY21	75-27-4	Bromodichloromethane	1	µg/L	U
B1DY21	7440-43-9	Cadmium	0.04	µg/L	U
B25NB6	7440-43-9	Cadmium	0.1	µg/L	U
B30T80	7440-43-9	Cadmium	0.11	µg/L	U
B32JY6	7440-43-9	Cadmium	0.11	µg/L	U
B1DY21	7440-70-2	Calcium	23,500	µg/L	
B25NB6	7440-70-2	Calcium	62,000	µg/L	
B30T80	7440-70-2	Calcium	57,600	µg/L	
B32JY6	7440-70-2	Calcium	51,600	µg/L	
B1DY21	86-74-8	Carbazole	0.42	µg/L	U
B1DY21	75-15-0	Carbon Disulfide	1	µg/L	U
B1DY21	56-23-5	Carbon Tetrachloride	1	µg/L	U
B1DY21	16887-00-6	Chloride	1.21	mg/L	
B25NB6	16887-00-6	Chloride	120	µg/mL	D
B30V15	16887-00-6	Chloride	58,900	µg/L	D

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DY21	108-90-7	Chlorobenzene	1	µg/L	U
B1DY21	67-66-3	Chloroform	1	µg/L	U
B1DY21	7440-47-3	Chromium	9.08	µg/L	
B25NB6	7440-47-3	Chromium	3.34	µg/L	B
B30T80	7440-47-3	Chromium	11.3	µg/L	
B32JY6	7440-47-3	Chromium	10	µg/L	
B1DY21	218-01-9	Chrysene	0.32	µg/L	U
B1DY21	7440-48-4	Cobalt	1.2	µg/L	U
B25NB6	7440-48-4	Cobalt	4	µg/L	U
B30T80	7440-48-4	Cobalt	0.1	µg/L	U
B32JY6	7440-48-4	Cobalt	0.1	µg/L	U
B1DY21	7440-50-8	Copper	6.78	µg/L	
B25NB6	7440-50-8	Copper	2.55	µg/L	
B30T80	7440-50-8	Copper	2.83	µg/L	
B32JY6	7440-50-8	Copper	2.46	µg/L	
B1DY21	57-12-5	Cyanide	4	µg/L	U
B1DY21	117-84-0	Di-n-octylphthalate	1.5	µg/L	U
B1DY21	122-39-4	Diphenylamine	0.43	µg/L	U
B1DY21	107-12-0	Ethyl Cyanide	2	µg/L	U
B1DY21	100-41-4	Ethylbenzene	1	µg/L	U
B1DY21	16984-48-8	Fluoride	0.71	mg/L	
B25NB6	16984-48-8	Fluoride	0.655	µg/mL	D
B30V15	16984-48-8	Fluoride	643	µg/L	
B1DY21	12587-46-1	Gross alpha	2.2	pCi/L	
B1J7K9	12587-46-1	Gross alpha	4.4	pCi/L	
B1L9P4	12587-46-1	Gross alpha	2.1	pCi/L	
B1NFR7	12587-46-1	Gross alpha	4.8	pCi/L	
B1R7F7	12587-46-1	Gross alpha	5.1	pCi/L	
B1VRX7	12587-46-1	Gross alpha	0.48	pCi/L	U
B1Y483	12587-46-1	Gross alpha	-0.98	pCi/L	U
B209L8	12587-46-1	Gross alpha	710	pCi/L	
B230F1	12587-46-1	Gross alpha	3.1	pCi/L	
B25NB6	12587-46-1	Gross alpha	8	pCi/L	
B2B4Y1	12587-46-1	Gross alpha	3.9	pCi/L	U
B2F0V1	12587-46-1	Gross alpha	4.4	pCi/L	
B2JP59	12587-46-1	Gross alpha	13	pCi/L	
B2LPL5	12587-46-1	Gross alpha	10	pCi/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B2N8C6	12587-46-1	Gross alpha	4.9	pCi/L	U
B2PLM3	12587-46-1	Gross alpha	4.7	pCi/L	
B2V4H6	12587-46-1	Gross alpha	7.8	pCi/L	
B30T80	12587-46-1	Gross alpha	5.79	pCi/L	
B32JY6	12587-46-1	Gross alpha	7.2	pCi/L	
B1DY21	12587-47-2	Gross beta	7.2	pCi/L	
B1J7K9	12587-47-2	Gross beta	5.1	pCi/L	
B1L9P4	12587-47-2	Gross beta	8	pCi/L	
B1NFR7	12587-47-2	Gross beta	9.4	pCi/L	
B1R7F7	12587-47-2	Gross beta	12.3	pCi/L	
B1VRX7	12587-47-2	Gross beta	3.6	pCi/L	
B1Y483	12587-47-2	Gross beta	-1.2	pCi/L	U
B209L8	12587-47-2	Gross beta	590	pCi/L	
B230F1	12587-47-2	Gross beta	5.3	pCi/L	
B25NB6	12587-47-2	Gross beta	13	pCi/L	
B2B4Y1	12587-47-2	Gross beta	9	pCi/L	
B2F0V1	12587-47-2	Gross beta	9.9	pCi/L	
B2JP59	12587-47-2	Gross beta	17	pCi/L	
B2LPL5	12587-47-2	Gross beta	9.1	pCi/L	
B2N8C6	12587-47-2	Gross beta	13	pCi/L	
B2PLM3	12587-47-2	Gross beta	7	pCi/L	
B2V4H6	12587-47-2	Gross beta	14	pCi/L	
B30T80	12587-47-2	Gross beta	9.05	pCi/L	
B32JY6	12587-47-2	Gross beta	9.85	pCi/L	
B1DY21	118-74-1	Hexachlorobenzene	1.2	µg/L	U
B1DY21	77-47-4	Hexachlorocyclopentadiene	0.63	µg/L	U
B1DY21	67-72-1	Hexachloroethane	1.1	µg/L	U
B1DY21	7439-89-6	Iron	109	µg/L	C
B25NB6	7439-89-6	Iron	76	µg/L	B
B30T80	7439-89-6	Iron	89.1	µg/L	B
B32JY6	7439-89-6	Iron	101	µg/L	
B1DY21	78-59-1	Isophorone	0.45	µg/L	U
B1DY21	7439-92-1	Lead	0.772	µg/L	
B25NB6	7439-92-1	Lead	0.182	µg/L	B
B30T80	7439-92-1	Lead	0.5	µg/L	U
B32JY6	7439-92-1	Lead	0.5	µg/L	U
B1DY21	7439-95-4	Magnesium	5,010	µg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B25NB6	7439-95-4	Magnesium	14,600	µg/L	
B30T80	7439-95-4	Magnesium	13,700	µg/L	
B32JY6	7439-95-4	Magnesium	12,800	µg/L	
B1DY21	7439-96-5	Manganese	6	µg/L	
B25NB6	7439-96-5	Manganese	4	µg/L	U
B30T80	7439-96-5	Manganese	2.36	µg/L	B
B32JY6	7439-96-5	Manganese	2.33	µg/L	B
B1DY21	7439-97-6	Mercury	0.083	µg/L	CE
B25NB6	7439-97-6	Mercury	0.05	µg/L	U
B30T80	7439-97-6	Mercury	0.075	µg/L	CB
B32JY6	7439-97-6	Mercury	0.067	µg/L	U
B1DY21	75-09-2	Methylene Chloride	1	µg/L	U
B1DY21	91-20-3	Naphthalene	1.5	µg/L	U
B1DY21	7440-02-0	Nickel	1.4	µg/L	U
B25NB6	7440-02-0	Nickel	4	µg/L	U
B30T80	7440-02-0	Nickel	0.5	µg/L	U
B32JY6	7440-02-0	Nickel	0.5	µg/L	U
B1DY21	NH4-N	Nitrogen in Ammonium	0.004	mg/L	U
B1DY21	NO3-N	Nitrogen in Nitrate	2.63	mg/L	
B25NB6	NO3-N	Nitrogen in Nitrate	32.8	µg/mL	D
B30V15	NO3-N	Nitrogen in Nitrate	21,800	µg/L	DX
B1DY21	NO2-N	Nitrogen in Nitrite	0.01	mg/L	U
B25NB6	NO2-N	Nitrogen in Nitrite	0.036	µg/mL	UD
B30V15	NO2-N	Nitrogen in Nitrite	38	µg/L	UX
B1DY21	62-75-9	n-Nitrosodimethylamine	0.65	µg/L	U
B1DY21	621-64-7	n-Nitrosodi-n-dipropylamine	0.47	µg/L	U
B1DY21	87-86-5	Pentachlorophenol	0.67	µg/L	U
B1DY21	PH	pH Measurement	7.79	unitless	
B1J7K9	PH	pH Measurement	8.09	unitless	
B1L9P4	PH	pH Measurement	8.01	unitless	
B1NFR7	PH	pH Measurement	7.79	unitless	
B1R7F7	PH	pH Measurement	8.25	unitless	
B1VRX7	PH	pH Measurement	8.04	unitless	
B1Y483	PH	pH Measurement	7.99	unitless	
B209L8	PH	pH Measurement	7.95	unitless	
B230F1	PH	pH Measurement	7.05	unitless	
B25NB6	PH	pH Measurement	7.82	unitless	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B2B4Y1	PH	pH Measurement	8.1	unitless	
B2F0V1	PH	pH Measurement	7.93	unitless	
B2JP59	PH	pH Measurement	8.01	unitless	
B2LPL5	PH	pH Measurement	7.27	unitless	
B2N8C6	PH	pH Measurement	8.12	unitless	
B2PLM3	PH	pH Measurement	7.84	unitless	
B2V4H6	PH	pH Measurement	8.34	unitless	
B30T80	PH	pH Measurement	8.16	unitless	X
B1DY21	108-95-2	Phenol	0.59	µg/L	U
B1DY21	PO4-P	Phosphorus in Phosphate	0.119	mg/L	
B25NB6	PO4-P	Phosphorus in Phosphate	0.148	µg/mL	BD
B30V15	PO4-P	Phosphorus in Phosphate	113	µg/L	BX
B1DY21	9/7/7440	Potassium	5,960	µg/L	
B25NB6	9/7/7440	Potassium	8,450	µg/L	
B30T80	9/7/7440	Potassium	7,180	µg/L	
B32JY6	9/7/7440	Potassium	7,560	µg/L	
B1DY21	129-00-0	Pyrene	0.34	µg/L	U
B1DY21	110-86-1	Pyridine	0.44	µg/L	U
B1DY21	7782-49-2	Selenium	0.925	µg/L	E
B25NB6	7782-49-2	Selenium	3.83	µg/L	C
B30T80	7782-49-2	Selenium	2.77	µg/L	B
B32JY6	7782-49-2	Selenium	2.67	µg/L	B
B1DY21	7440-21-3	Silicon	38,200	µg/L	
B25NB6	7440-21-3	Silicon	15,800	µg/L	
B30T80	7440-21-3	Silicon	15,800	µg/L	
B32JY6	7440-21-3	Silicon	16,700	µg/L	
B1DY21	7440-22-4	Silver	1.8	µg/L	U
B25NB6	7440-22-4	Silver	5	µg/L	U
B30T80	7440-22-4	Silver	0.2	µg/L	U
B32JY6	7440-22-4	Silver	0.2	µg/L	U
B1DY21	7440-23-5	Sodium	53,200	µg/L	
B25NB6	7440-23-5	Sodium	130,000	µg/L	
B30T80	7440-23-5	Sodium	94,000	µg/L	
B32JY6	7440-23-5	Sodium	88,500	µg/L	
B1DY21	CONDUCT	Specific Conductance	355	µS/cm	
B1DY21	14808-79-8	Sulfate	14.3	mg/L	
B25NB6	14808-79-8	Sulfate	38.3	µg/mL	D

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B30V15	14808-79-8	Sulfate	45,400	µg/L	D
B1DY21	127-18-4	Tetrachloroethene	1	µg/L	U
B1DY21	109-99-9	Tetrahydrofuran	2	µg/L	U
B1DY21	7440-28-0	Thallium	20	µg/L	U
B25NB6	7440-28-0	Thallium	35	µg/L	U
B30T80	7440-28-0	Thallium	0.45	µg/L	U
B32JY6	7440-28-0	Thallium	0.45	µg/L	U
B1DY21	7440-32-6	Titanium	1.4	µg/L	U
B25NB6	7440-32-6	Titanium	4	µg/L	U
B1DY21	108-88-3	Toluene	1	µg/L	U
B1DY21	1319-77-3	Total cresols	0.89	µg/L	U
B1DY21	TDS	Total dissolved solids	253	mg/L	
B1J7K9	TDS	Total dissolved solids	374	mg/L	
B1L9P4	TDS	Total dissolved solids	301	mg/L	
B1NFR7	TDS	Total dissolved solids	397	mg/L	
B1R7F7	TDS	Total dissolved solids	238	mg/L	
B1VRX7	TDS	Total dissolved solids	306	mg/L	
B1Y483	TDS	Total dissolved solids	1,020	mg/L	
B209L8	TDS	Total dissolved solids	484	mg/L	
B230F1	TDS	Total dissolved solids	490	mg/L	
B25NB6	TDS	Total dissolved solids	671	mg/L	
B2B4Y1	TDS	Total dissolved solids	671	mg/L	
B2F0V1	TDS	Total dissolved solids	556	mg/L	
B2JP59	TDS	Total dissolved solids	646	mg/L	
B2LPL5	TDS	Total dissolved solids	551	mg/L	
B2N8C6	TDS	Total dissolved solids	538	mg/L	
B2PLM3	TDS	Total dissolved solids	484	mg/L	
B2V4H6	TDS	Total dissolved solids	603	mg/L	
B30T80	TDS	Total dissolved solids	523,000	µg/L	
B32JY6	TDS	Total dissolved solids	481,000	µg/L	
B1DY21	TOC	Total organic carbon	2.8	mg/L	
B1J7K9	TOC	Total organic carbon	3.93	mg/L	
B1L9P4	TOC	Total organic carbon	3.71	mg/L	X
B1NFR7	TOC	Total organic carbon	3.77	mg/L	
B1R7F7	TOC	Total organic carbon	2.16	mg/L	
B1VRX7	TOC	Total organic carbon	2.04	mg/L	
B1Y483	TOC	Total organic carbon	3.3	mg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B209L8	TOC	Total organic carbon	3.54	mg/L	
B230F1	TOC	Total organic carbon	3.18	mg/L	
B25NB6	TOC	Total organic carbon	3.7	mg/L	
B2B4Y1	TOC	Total organic carbon	2.93	mg/L	
B2F0V1	TOC	Total organic carbon	2.51	mg/L	
B2JP59	TOC	Total organic carbon	2.83	mg/L	
B2LPL5	TOC	Total organic carbon	2.5	mg/L	
B2N8C6	TOC	Total organic carbon	3.93	mg/L	
B2PLM3	TOC	Total organic carbon	3.38	mg/L	
B2V4H6	TOC	Total organic carbon	3.65	mg/L	
B30T80	TOC	Total organic carbon	3.4	mg/L	
B32JY6	TOC	Total organic carbon	2,850	μg/L	
B1DY21	TSS	Total suspended solids	1	mg/L	U
B1J7K9	TSS	Total suspended solids	1	mg/L	
B1L9P4	TSS	Total suspended solids	1	mg/L	U
B1NFR7	TSS	Total suspended solids	1	mg/L	U
B1R7F7	TSS	Total suspended solids	41.2	mg/L	X
B1VRX7	TSS	Total suspended solids	1	mg/L	U
B1Y483	TSS	Total suspended solids	3	mg/L	
B209L8	TSS	Total suspended solids	2	mg/L	U
B230F1	TSS	Total suspended solids	4.44	mg/L	B
B25NB6	TSS	Total suspended solids	2	mg/L	U
B2B4Y1	TSS	Total suspended solids	2	mg/L	U
B2F0V1	TSS	Total suspended solids	2	mg/L	U
B2JP59	TSS	Total suspended solids	2	mg/L	U
B2LPL5	TSS	Total suspended solids	2	mg/L	U
B2N8C6	TSS	Total suspended solids	10	mg/L	U
B2PLM3	TSS	Total suspended solids	2	mg/L	U
B2V4H6	TSS	Total suspended solids	2	mg/L	U
B30T80	TSS	Total suspended solids	1.4	mg/L	B
B32JY6	TSS	Total suspended solids	0.87	mg/L	B
B1DY21	126-73-8	Tributyl Phosphate	0.14	μg/L	U
B1DY21	79-01-6	Trichloroethene	1	μg/L	U
B1DY21	7440-61-1	Uranium	3.54	μg/L	
B1J7K9	7440-61-1	Uranium	5.24	μg/L	
B1L9P4	7440-61-1	Uranium	3.66	μg/L	
B1NFR7	7440-61-1	Uranium	6.03	μg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1R7F7	7440-61-1	Uranium	4.2	µg/L	
B1VRX7	7440-61-1	Uranium	4.12	µg/L	
B1Y483	7440-61-1	Uranium	0.05	µg/L	U
B209L8	7440-61-1	Uranium	7.69	µg/L	
B230F1	7440-61-1	Uranium	11.3	µg/L	
B25NB6	7440-61-1	Uranium	11.9	µg/L	
B2B4Y1	7440-61-1	Uranium	10.5	µg/L	
B2F0V1	7440-61-1	Uranium	12.6	µg/L	
B2JP59	7440-61-1	Uranium	20	µg/L	
B2LPL5	7440-61-1	Uranium	15.9	µg/L	
B2N8C6	7440-61-1	Uranium	14.5	µg/L	
B2PLM3	7440-61-1	Uranium	9.64	µg/L	
B2V4H6	7440-61-1	Uranium	16.4	µg/L	
B30T80	7440-61-1	Uranium	15.2	µg/L	
B32JY6	7440-61-1	Uranium	13.5	µg/L	
B1DY21	7440-62-2	Vanadium	27	µg/L	
B25NB6	7440-62-2	Vanadium	17	µg/L	B
B30T80	7440-62-2	Vanadium	20.5	µg/L	
B32JY6	7440-62-2	Vanadium	21	µg/L	
B1DY21	75-01-4	Vinyl Chloride	1	µg/L	U
B1DY21	1330-20-7	Xylenes (Total)	1	µg/L	U
B1DY21	7440-66-6	Zinc	3	µg/L	U
B25NB6	7440-66-6	Zinc	6	µg/L	U
B30T80	7440-66-6	Zinc	3.5	µg/L	U
B32JY6	7440-66-6	Zinc	3.5	µg/L	U
B1DYH5	71-55-6	1,1,1-Trichloroethane	1	µg/L	U
B1DYH5	79-00-5	1,1,2-Trichloroethane	1	µg/L	U
B1DYH5	75-34-3	1,1-Dichloroethane	1	µg/L	U
B1DYH5	75-35-4	1,1-Dichloroethene	1	µg/L	U
B1DYH5	120-82-1	1,2,4-Trichlorobenzene	1.9	µg/L	U
B1DYH5	107-06-2	1,2-Dichloroethane	1	µg/L	U
B1DYH5	540-59-0	1,2-Dichloroethene (Total)	1	µg/L	U
B1DYH5	106-46-7	1,4-Dichlorobenzene	1	µg/L	U
B1DYH5	106-46-7	1,4-Dichlorobenzene	1.5	µg/L	U
B1DYH5	71-36-3	1-Butanol	100	µg/L	U
B1DYH5	88-06-2	2,4,6-Trichlorophenol	0.55	µg/L	U
B1DYH5	121-14-2	2,4-Dinitrotoluene	0.42	µg/L	U

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DYH5	78-93-3	2-Butanone	1	µg/L	U
B1DYH5	111-76-2	2-Butoxyethanol	0.74	µg/L	U
B1DYH5	95-57-8	2-Chlorophenol	2.4	µg/L	U
B1DYH5	591-78-6	2-Hexanone	1	µg/L	U
B1DYH5	95-48-7	2-Methylphenol (cresol, o-)	0.27	µg/L	U
B1DYH5	107-87-9	2-Pentanone	1	µg/L	U
B1DYH5	65794-96-9	3+4 Methylphenol (cresol, m+p)	0.7	µg/L	U
B1DYH5	59-50-7	4-Chloro-3-methylphenol	0.52	µg/L	U
B1DYH5	106-47-8	4-Chloroaniline	0.63	µg/L	U
B1DYH5	108-10-1	4-Methyl-2-pentanone	1	µg/L	U
B1DYH5	100-02-7	4-Nitrophenol	1.3	µg/L	U
B1DYH5	83-32-9	Acenaphthene	3.1	µg/L	U
B1DYH5	67-64-1	Acetone	1	µg/L	U
B1DYH5	75-05-8	Acetonitrile	2	µg/L	U
B1DYH5	98-86-2	Acetophenone	0.37	µg/L	U
B1DYH5	7429-90-5	Aluminum	63.5	µg/L	C
B25NB7	7429-90-5	Aluminum	21	µg/L	B
B30T81	7429-90-5	Aluminum	35.6	µg/L	B
B32JY7	7429-90-5	Aluminum	75.1	µg/L	
B1DYH5	7440-36-0	Antimony	1.39	µg/L	C
B1DYH5	7440-36-0	Antimony	25	µg/L	U
B25NB7	7440-36-0	Antimony	0.326	µg/L	B
B30T81	7440-36-0	Antimony	1	µg/L	U
B32JY7	7440-36-0	Antimony	1	µg/L	U
B1DYH5	12674-11-2	Aroclor-1016	0.1	µg/L	U
B1DYH5	11104-28-2	Aroclor-1221	0.21	µg/L	U
B1DYH5	11141-16-5	Aroclor-1232	0.1	µg/L	U
B1DYH5	53469-21-9	Aroclor-1242	0.1	µg/L	U
B1DYH5	12672-29-6	Aroclor-1248	0.1	µg/L	U
B1DYH5	11097-69-1	Aroclor-1254	0.1	µg/L	U
B1DYH5	11096-82-5	Aroclor-1260	0.1	µg/L	U
B1DYH5	7440-38-2	Arsenic	18.5	µg/L	
B25NB7	7440-38-2	Arsenic	18.8	µg/L	
B30T81	7440-38-2	Arsenic	16.1	µg/L	
B32JY7	7440-38-2	Arsenic	14.9	µg/L	
B1DYH5	7440-39-3	Barium	28	µg/L	
B25NB7	7440-39-3	Barium	58	µg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DYH5	71-43-2	Benzene	1	µg/L	U
B1DYH5	100-51-6	Benzyl Alcohol	0.33	µg/L	U
B1DYH5	7440-41-7	Beryllium	0.5	µg/L	U
B25NB7	7440-41-7	Beryllium	0.05	µg/L	U
B25NB7	7440-41-7	Beryllium	4	µg/L	U
B30T81	7440-41-7	Beryllium	0.2	µg/L	U
B32JY7	7440-41-7	Beryllium	0.2	µg/L	U
B1DYH5	108-60-1	Bis(2-chloro-1-methylethyl)ether	1.6	µg/L	U
B1DYH5	24959-67-9	Bromide	0.093	mg/L	U
B25NB7	24959-67-9	Bromide	0.09	µg/mL	UD
B1DYH5	75-27-4	Bromodichloromethane	1	µg/L	U
B1DYH5	7440-43-9	Cadmium	0.04	µg/L	U
B25NB7	7440-43-9	Cadmium	0.1	µg/L	U
B30T81	7440-43-9	Cadmium	0.11	µg/L	U
B32JY7	7440-43-9	Cadmium	0.11	µg/L	U
B1DYH5	7440-70-2	Calcium	37,000	µg/L	
B25NB7	7440-70-2	Calcium	62,100	µg/L	
B30T81	7440-70-2	Calcium	57,700	µg/L	
B32JY7	7440-70-2	Calcium	50,600	µg/L	
B1DYH5	86-74-8	Carbazole	0.45	µg/L	U
B1DYH5	75-15-0	Carbon Disulfide	1	µg/L	U
B1DYH5	56-23-5	Carbon Tetrachloride	1	µg/L	U
B1DYH5	16887-00-6	Chloride	4.08	mg/L	
B25NB7	16887-00-6	Chloride	29.8	µg/mL	D
B30V16	16887-00-6	Chloride	16,100	µg/L	D
B1DYH5	108-90-7	Chlorobenzene	1	µg/L	U
B1DYH5	67-66-3	Chloroform	1	µg/L	U
B1DYH5	7440-47-3	Chromium	4.52	µg/L	
B25NB7	7440-47-3	Chromium	22.9	µg/L	
B30T81	7440-47-3	Chromium	25.5	µg/L	
B32JY7	7440-47-3	Chromium	28.5	µg/L	
B1DYH5	218-01-9	Chrysene	0.34	µg/L	U
B1DYH5	7440-48-4	Cobalt	2.1	µg/L	C
B25NB7	7440-48-4	Cobalt	4	µg/L	U
B30T81	7440-48-4	Cobalt	0.158	µg/L	B
B32JY7	7440-48-4	Cobalt	0.18	µg/L	CB
B1DYH5	7440-50-8	Copper	2.38	µg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B25NB7	7440-50-8	Copper	2.15	µg/L	
B30T81	7440-50-8	Copper	8.11	µg/L	
B32JY7	7440-50-8	Copper	4.47	µg/L	
B1DYH5	57-12-5	Cyanide	4	µg/L	U
B1DYH5	117-84-0	Di-n-octylphthalate	1.6	µg/L	U
B1DYH5	122-39-4	Diphenylamine	0.46	µg/L	U
B1DYH5	107-12-0	Ethyl Cyanide	2	µg/L	U
B1DYH5	100-41-4	Ethylbenzene	1	µg/L	U
B1DYH5	16984-48-8	Fluoride	0.469	mg/L	
B25NB7	16984-48-8	Fluoride	0.418	µg/mL	D
B30V16	16984-48-8	Fluoride	490	µg/L	B
B1DYH5	12587-46-1	Gross alpha	3.9	pCi/L	
B1J7L0	12587-46-1	Gross alpha	12	pCi/L	
B1L9P5	12587-46-1	Gross alpha	3.6	pCi/L	
B1NFR8	12587-46-1	Gross alpha	6.4	pCi/L	
B1R7F8	12587-46-1	Gross alpha	6.9	pCi/L	
B1VRX8	12587-46-1	Gross alpha	3.7	pCi/L	
B1Y484	12587-46-1	Gross alpha	5.2	pCi/L	
B209L9	12587-46-1	Gross alpha	4.2	pCi/L	
B230F2	12587-46-1	Gross alpha	13	pCi/L	
B25NB7	12587-46-1	Gross alpha	7.6	pCi/L	
B2B4Y2	12587-46-1	Gross alpha	7	pCi/L	
B2F0V2	12587-46-1	Gross alpha	7.4	pCi/L	
B2JP60	12587-46-1	Gross alpha	13	pCi/L	
B2LPL6	12587-46-1	Gross alpha	12	pCi/L	
B2N8C7	12587-46-1	Gross alpha	9.5	pCi/L	
B2PLM4	12587-46-1	Gross alpha	11	pCi/L	
B2V4H7	12587-46-1	Gross alpha	9.5	pCi/L	
B30T81	12587-46-1	Gross alpha	15.8	pCi/L	
B32JY7	12587-46-1	Gross alpha	16.9	pCi/L	
B1DYH5	12587-47-2	Gross beta	3.9	pCi/L	
B1J7L0	12587-47-2	Gross beta	8.7	pCi/L	
B1L9P5	12587-47-2	Gross beta	9.3	pCi/L	
B1NFR8	12587-47-2	Gross beta	10.3	pCi/L	
B1R7F8	12587-47-2	Gross beta	9.1	pCi/L	
B1VRX8	12587-47-2	Gross beta	6.2	pCi/L	
B1Y484	12587-47-2	Gross beta	9.4	pCi/L	U

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B209L9	12587-47-2	Gross beta	5.4	pCi/L	
B230F2	12587-47-2	Gross beta	11	pCi/L	
B25NB7	12587-47-2	Gross beta	12	pCi/L	
B2B4Y2	12587-47-2	Gross beta	10	pCi/L	
B2F0V2	12587-47-2	Gross beta	11	pCi/L	
B2JP60	12587-47-2	Gross beta	9	pCi/L	
B2LPL6	12587-47-2	Gross beta	9.8	pCi/L	
B2N8C7	12587-47-2	Gross beta	25	pCi/L	
B2PLM4	12587-47-2	Gross beta	8.2	pCi/L	
B2V4H7	12587-47-2	Gross beta	14	pCi/L	
B30T81	12587-47-2	Gross beta	13.9	pCi/L	
B32JY7	12587-47-2	Gross beta	7.38	pCi/L	
B1DYH5	118-74-1	Hexachlorobenzene	1.3	µg/L	U
B1DYH5	77-47-4	Hexachlorocyclopentadiene	0.68	µg/L	U
B1DYH5	67-72-1	Hexachloroethane	1.2	µg/L	U
B1DYH5	7439-89-6	Iron	31.1	µg/L	C
B25NB7	7439-89-6	Iron	56	µg/L	B
B30T81	7439-89-6	Iron	70.3	µg/L	B
B32JY7	7439-89-6	Iron	225	µg/L	
B1DYH5	78-59-1	Isophorone	0.48	µg/L	U
B1DYH5	7439-92-1	Lead	0.288	µg/L	
B25NB7	7439-92-1	Lead	0.1	µg/L	U
B30T81	7439-92-1	Lead	0.5	µg/L	U
B32JY7	7439-92-1	Lead	0.888	µg/L	CB
B1DYH5	7439-95-4	Magnesium	8,010	µg/L	
B25NB7	7439-95-4	Magnesium	13,200	µg/L	
B30T81	7439-95-4	Magnesium	13,100	µg/L	
B32JY7	7439-95-4	Magnesium	11,900	µg/L	
B1DYH5	7439-96-5	Manganese	1	µg/L	
B25NB7	7439-96-5	Manganese	4	µg/L	U
B30T81	7439-96-5	Manganese	1	µg/L	U
B32JY7	7439-96-5	Manganese	3.96	µg/L	B
B1DYH5	7439-97-6	Mercury	0.04	µg/L	U
B25NB7	7439-97-6	Mercury	0.05	µg/L	U
B30T81	7439-97-6	Mercury	0.067	µg/L	U
B32JY7	7439-97-6	Mercury	0.067	µg/L	U
B1DYH5	75-09-2	Methylene Chloride	1	µg/L	U

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DYH5	91-20-3	Naphthalene	1.6	µg/L	U
B1DYH5	7440-02-0	Nickel	1.4	µg/L	
B25NB7	7440-02-0	Nickel	4	µg/L	U
B30T81	7440-02-0	Nickel	0.5	µg/L	U
B32JY7	7440-02-0	Nickel	0.537	µg/L	B
B1DYH5	NH4-N	Nitrogen in Ammonium	0.004	mg/L	U
B1DYH5	NO3-N	Nitrogen in Nitrate	7.11	mg/L	
B25NB7	NO3-N	Nitrogen in Nitrate	19.1	µg/mL	D
B30V16	NO3-N	Nitrogen in Nitrate	14,100	µg/L	DX
B1DYH5	NO2-N	Nitrogen in Nitrite	0.01	mg/L	U
B25NB7	NO2-N	Nitrogen in Nitrite	0.036	µg/mL	UD
B30V16	NO2-N	Nitrogen in Nitrite	38	µg/L	UX
B1DYH5	62-75-9	n-Nitrosodimethylamine	0.7	µg/L	U
B1DYH5	621-64-7	n-Nitrosodi-n-dipropylamine	0.51	µg/L	U
B1DYH5	87-86-5	Pentachlorophenol	0.73	µg/L	U
B1DYH5	PH	pH Measurement	8.25	unitless	
B1J7L0	PH	pH Measurement	8.91	unitless	
B1L9P5	PH	pH Measurement	7.89	unitless	
B1NFR8	PH	pH Measurement	7.87	unitless	
B1R7F8	PH	pH Measurement	8.06	unitless	
B1VRX8	PH	pH Measurement	8.01	unitless	
B1Y484	PH	pH Measurement	8.1	unitless	
B209L9	PH	pH Measurement	8.06	unitless	
B230F2	PH	pH Measurement	7.82	unitless	
B25NB7	PH	pH Measurement	7.81	unitless	
B2B4Y2	PH	pH Measurement	7.99	unitless	
B2F0V2	PH	pH Measurement	8	unitless	
B2JP60	PH	pH Measurement	8.22	unitless	
B2LPL6	PH	pH Measurement	7.84	unitless	
B2N8C7	PH	pH Measurement	7.97	unitless	
B2PLM4	PH	pH Measurement	7.69	unitless	
B2V4H7	PH	pH Measurement	8.14	unitless	
B30T81	PH	pH Measurement	8.15	unitless	X
B1DYH5	108-95-2	Phenol	0.64	µg/L	U
B1DYH5	PO4-P	Phosphorus in Phosphate	0.078	mg/L	U
B25NB7	PO4-P	Phosphorus in Phosphate	0.14	µg/mL	UD
B30V16	PO4-P	Phosphorus in Phosphate	70.5	µg/L	BX

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DYH5	9/7/7440	Potassium	5,530	µg/L	
B25NB7	9/7/7440	Potassium	7,130	µg/L	
B30T81	9/7/7440	Potassium	6,970	µg/L	
B32JY7	9/7/7440	Potassium	6,830	µg/L	
B1DYH5	129-00-0	Pyrene	0.36	µg/L	U
B1DYH5	110-86-1	Pyridine	0.47	µg/L	U
B1DYH5	7782-49-2	Selenium	0.798	µg/L	E
B25NB7	7782-49-2	Selenium	1.42	µg/L	B
B30T81	7782-49-2	Selenium	1.87	µg/L	B
B32JY7	7782-49-2	Selenium	1.89	µg/L	B
B1DYH5	7440-21-3	Silicon	31,500	µg/L	
B25NB7	7440-21-3	Silicon	17,200	µg/L	
B30T81	7440-21-3	Silicon	15,600	µg/L	
B32JY7	7440-21-3	Silicon	15,700	µg/L	
B1DYH5	7440-22-4	Silver	1.8	µg/L	U
B25NB7	7440-22-4	Silver	5	µg/L	U
B30T81	7440-22-4	Silver	0.2	µg/L	U
B32JY7	7440-22-4	Silver	0.2	µg/L	U
B1DYH5	7440-23-5	Sodium	55,600	µg/L	
B25NB7	7440-23-5	Sodium	122,000	µg/L	
B30T81	7440-23-5	Sodium	116,000	µg/L	
B32JY7	7440-23-5	Sodium	101,000	µg/L	
B1DYH5	CONDUCT	Specific Conductance	451	µS/cm	
B1DYH5	14808-79-8	Sulfate	40.8	mg/L	
B25NB7	14808-79-8	Sulfate	86.3	µg/mL	D
B30V16	14808-79-8	Sulfate	71,600	µg/L	D
B1DYH5	127-18-4	Tetrachloroethene	1	µg/L	U
B1DYH5	109-99-9	Tetrahydrofuran	2	µg/L	U
B1DYH5	7440-28-0	Thallium	20	µg/L	U
B25NB7	7440-28-0	Thallium	35	µg/L	U
B30T81	7440-28-0	Thallium	0.45	µg/L	U
B32JY7	7440-28-0	Thallium	0.45	µg/L	U
B1DYH5	7440-32-6	Titanium	1.4	µg/L	U
B25NB7	7440-32-6	Titanium	4	µg/L	U
B1DYH5	108-88-3	Toluene	1	µg/L	U
B1DYH5	1319-77-3	Total cresols	0.96	µg/L	U
B1DYH5	TDS	Total dissolved solids	286	mg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1J7L0	TDS	Total dissolved solids	468	mg/L	
B1L9P5	TDS	Total dissolved solids	245	mg/L	
B1NFR8	TDS	Total dissolved solids	446	mg/L	
B1R7F8	TDS	Total dissolved solids	9	mg/L	U
B1VRX8	TDS	Total dissolved solids	386	mg/L	
B1Y484	TDS	Total dissolved solids	623	mg/L	
B209L9	TDS	Total dissolved solids	632	mg/L	
B230F2	TDS	Total dissolved solids	663	mg/L	
B25NB7	TDS	Total dissolved solids	578	mg/L	
B2B4Y2	TDS	Total dissolved solids	750	mg/L	
B2F0V2	TDS	Total dissolved solids	620	mg/L	
B2JP60	TDS	Total dissolved solids	706	mg/L	
B2LPL6	TDS	Total dissolved solids	573	mg/L	
B2N8C7	TDS	Total dissolved solids	563	mg/L	
B2PLM4	TDS	Total dissolved solids	539	mg/L	
B2V4H7	TDS	Total dissolved solids	629	mg/L	
B30T81	TDS	Total dissolved solids	529,000	µg/L	
B32JY7	TDS	Total dissolved solids	457,000	µg/L	
B1DYH5	TOC	Total organic carbon	2.54	mg/L	
B1J7L0	TOC	Total organic carbon	2.81	mg/L	
B1L9P5	TOC	Total organic carbon	4.51	mg/L	X
B1NFR8	TOC	Total organic carbon	2.42	mg/L	
B1R7F8	TOC	Total organic carbon	2.96	mg/L	
B1VRX8	TOC	Total organic carbon	1.74	mg/L	
B1Y484	TOC	Total organic carbon	2.22	mg/L	
B209L9	TOC	Total organic carbon	3.61	mg/L	
B230F2	TOC	Total organic carbon	3.18	mg/L	
B25NB7	TOC	Total organic carbon	3.56	mg/L	
B2B4Y2	TOC	Total organic carbon	3.78	mg/L	
B2F0V2	TOC	Total organic carbon	3.69	mg/L	
B2JP60	TOC	Total organic carbon	3.09	mg/L	
B2LPL6	TOC	Total organic carbon	3.12	mg/L	
B2N8C7	TOC	Total organic carbon	4.28	mg/L	
B2PLM4	TOC	Total organic carbon	3.09	mg/L	
B2V4H7	TOC	Total organic carbon	4.12	mg/L	
B30T81	TOC	Total organic carbon	2.8	mg/L	
B32JY7	TOC	Total organic carbon	2,410	µg/L	

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B1DYH5	TSS	Total suspended solids	1	mg/L	U
B1J7L0	TSS	Total suspended solids	5.8	mg/L	X
B1L9P5	TSS	Total suspended solids	1	mg/L	U
B1NFR8	TSS	Total suspended solids	1	mg/L	U
B1R7F8	TSS	Total suspended solids	1	mg/L	U
B1VRX8	TSS	Total suspended solids	1	mg/L	U
B1Y484	TSS	Total suspended solids	5.6	mg/L	B
B209L9	TSS	Total suspended solids	2	mg/L	U
B230F2	TSS	Total suspended solids	2	mg/L	U
B25NB7	TSS	Total suspended solids	2	mg/L	U
B2B4Y2	TSS	Total suspended solids	2	mg/L	U
B2F0V2	TSS	Total suspended solids	2	mg/L	U
B2JP60	TSS	Total suspended solids	2	mg/L	U
B2LPL6	TSS	Total suspended solids	2	mg/L	U
B2N8C7	TSS	Total suspended solids	10	mg/L	U
B2PLM4	TSS	Total suspended solids	2	mg/L	U
B2V4H7	TSS	Total Suspended Solids	2	mg/L	U
B30T81	TSS	Total Suspended Solids	2.4	mg/L	B
B32JY7	TSS	Total Suspended Solids	1.9	mg/L	B
B1DYH5	126-73-8	Tributyl Phosphate	0.15	µg/L	U
B1DYH5	79-01-6	Trichloroethene	1	µg/L	U
B1DYH5	7440-61-1	Uranium	10.4	µg/L	
B1J7L0	7440-61-1	Uranium	16.6	µg/L	
B1L9P5	7440-61-1	Uranium	7.33	µg/L	
B1NFR8	7440-61-1	Uranium	18.8	µg/L	
B1R7F8	7440-61-1	Uranium	17.1	µg/L	
B1VRX8	7440-61-1	Uranium	12.6	µg/L	
B1Y484	7440-61-1	Uranium	13.9	µg/L	
B209L9	7440-61-1	Uranium	17.5	µg/L	
B230F2	7440-61-1	Uranium	16.8	µg/L	
B25NB7	7440-61-1	Uranium	18.8	µg/L	
B2B4Y2	7440-61-1	Uranium	23.5	µg/L	
B2F0V2	7440-61-1	Uranium	20.8	µg/L	X
B2JP60	7440-61-1	Uranium	27.2	µg/L	
B2LPL6	7440-61-1	Uranium	18	µg/L	
B2N8C7	7440-61-1	Uranium	21.3	µg/L	
B2PLM4	7440-61-1	Uranium	38.9	µg/L	D

Table A-2. Mixed Waste Trench Leachate Sample Results

Sample Number	Chemical Abstracts Service Number	Constituent	Reported Value	Units	Lab Qualifier
B2V4H7	7440-61-1	Uranium	25.4	µg/L	
B30T81	7440-61-1	Uranium	26.3	µg/L	
B32JY7	7440-61-1	Uranium	18.8	µg/L	
B1DYH5	7440-62-2	Vanadium	33	µg/L	
B25NB7	7440-62-2	Vanadium	24	µg/L	B
B30T81	7440-62-2	Vanadium	26.6	µg/L	
B32JY7	7440-62-2	Vanadium	23.9	µg/L	
B1DYH5	75-01-4	Vinyl Chloride	1	µg/L	U
B1DYH5	1330-20-7	Xylenes (Total)	1	µg/L	U
B1DYH5	7440-66-6	Zinc	3.5	µg/L	
B25NB7	7440-66-6	Zinc	6	µg/L	U
B30T81	7440-66-6	Zinc	3.5	µg/L	U
B32JY7	7440-66-6	Zinc	9.05	µg/L	B

Lab Qualifiers:

B = INORGANICS and WETCHEM - The analyte was detected at a value less than the contract RDL, but greater than or equal to the IDL/ MDL (as appropriate). ORGANICS - The analyte was detected in both the associated QC blank and in the sample. RATIONUCLIDES - The associated QC sample blank has a result >= 2X the MDA and, after corrections, result is >= MDA for this sample.

C = INORGANICS/WETCHEM: The analyte was detected in both the sample and the associated QC blank, and the sample concentration was <= 5X the blank concentration. ORGANICS (PESTICIDE only) - The identification of a pesticide confirmed by GC/MS.

D = ORGANICS/WETCHEM - Analyte was identified in an analysis at a secondary dilution factor (i.e., dilution factor different than 1.0).

E = INORGANICS - Reported value is estimated because of interference. ORGANICS - Concentration exceeds the calibration range of the GC/MS. Not applicable for PESTICIDES/PCBs.

U = ALL - Analyzed for but not detected above limiting criteria. NOTE: Limiting criteria may be any of the following: value reported < 0; value reported < counting error; value reported < total analytical error; value_rptd <=contract MDL/IDL/MDA/PQL.

X = ALL - Other specific flags and notes required to properly qualify the result are described in the hardcopy Sample Data Summary Package and/or Case narrative. Additional information may be found in the RESULT_COMMENT field for this record.

Blank = no qualifier
GC/MS = gas chromatograph/mass spectrometer
IDL = instrument detection limit
MDA = minimum detectable activity
MDL = method detection limit
QC = quality control
RDL = required detection limit

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Appendix B

ECF-200ZP1-16-0054, *Groundwater Flow and Migration Calculations to Support Assessment of the LLWMA-3 Trenches 31 and 34 Monitoring Network*

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ENVIRONMENTAL CALCULATION COVER PAGE

Section 1: Completed by the Responsible Manager

Project:		**RELEASE/ISSUE** 0
Date:	08/04/2016	
Calculation Title & Description:	**Groundwater Flow and Migration Calculations to Support Assessment of the LLBG Trenches 31 and 34 Monitoring Network**	

Section 2: Completed by Preparer

Calculation No.: ECF-200ZP1-16-0054 **Revision No.: 000**

Revision History

Revision No.	Description	Date	Affected Pages
0	Initial Issue	08/04/2016	

Section 3: Completed by the Responsible Manager
Document Control:

Is the document intended to be controlled within the Document Management Control System (DMCS)?	☒Yes☐No
Does document contain scientific and technical information intended for public use?	☒Yes☐No
Does document contain controlled-use information?	☐Yes☒No

Section 4: Document Review & Approval

Marinko Karanovic, Hydrogeologist, S.S. Papadopulos & Assoc., Inc.		08/04/2016
Preparer: *Name/Position*	*Signature*	*Date*
Cheng Cheng, INTERA Inc.		08/04/2016
Checker: *Name/Position*	*Signature*	*Date*
John Pickens, INTERA Inc.		08/04/2016
Senior Reviewer: *Name/Position*	*Signature*	*Date*
William Faught, CHPRC		08/04/2016
Responsible Manager: *Name /Position*	*Signature*	*Date* 8-4-16

Section 5: Applicable if Calculation is a Risk Assessment or Uses an Environmental Model

PRIOR TO INITIATING MODELING:

Required training for modelers completed:

Integration Lead *Name /Position*

Safety Software Approved:

Signature *Date*

Integration Lead *Name /Position*

Signature *Date*

CALCULATION APPROVED:

Risk/Modeling Integration Manager: *Name /Position*

Signature *Date*

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Contents

Appendices

Figures

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Terms

CHPRC	CH2M HILL Plateau Remediation Company
CPGWM	Central Plateau Groundwater Model
CY	calendar year
DQO	data quality objective
ECF	environmental calculation file
EMMA	Environmental Model Management Archive
FY	fiscal year
HISI	Hanford Information Systems Inventory
K_d	distribution coefficient
LLBG	Low-Level Burial Ground
LLWMA	low-level waste management area
MNA	monitored natural attenuation
MT3DMS	Modular 3-D Transport Multi-Species (computer code)
OU	operable unit
P&T	pump and treat
RCRA	*Resource Conservation and Recovery Act of 1976*
SSM	Sink/Source Mixing (Package)
SSP&A	S.S. Papadopulos and Associates, Inc.

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1 Purpose

This environmental calculation file (ECF) describes calculations made to evaluate monitoring locations for the Low Level Burial Ground (LLBG) Trenches 31 and 34 groundwater monitoring network for detecting significant increases in groundwater contamination that would result from potential releases from the two regulated units. The calculations evaluate the suitability of the current Low-Level Waste Management Area 3 (LLWMA-3) *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring network (depicted in Figure 1-1) and propose new locations, as needed, for detecting releases from Trenches 31 and 34, located within the LLWMA-3 boundary. The calculations were made to contribute to and support the publication of SGW-59564, *Evaluation of the 200 West Pump and Treat Influence on Groundwater Monitoring for the Low-Level Burial Ground Trenches 31 and 34*.

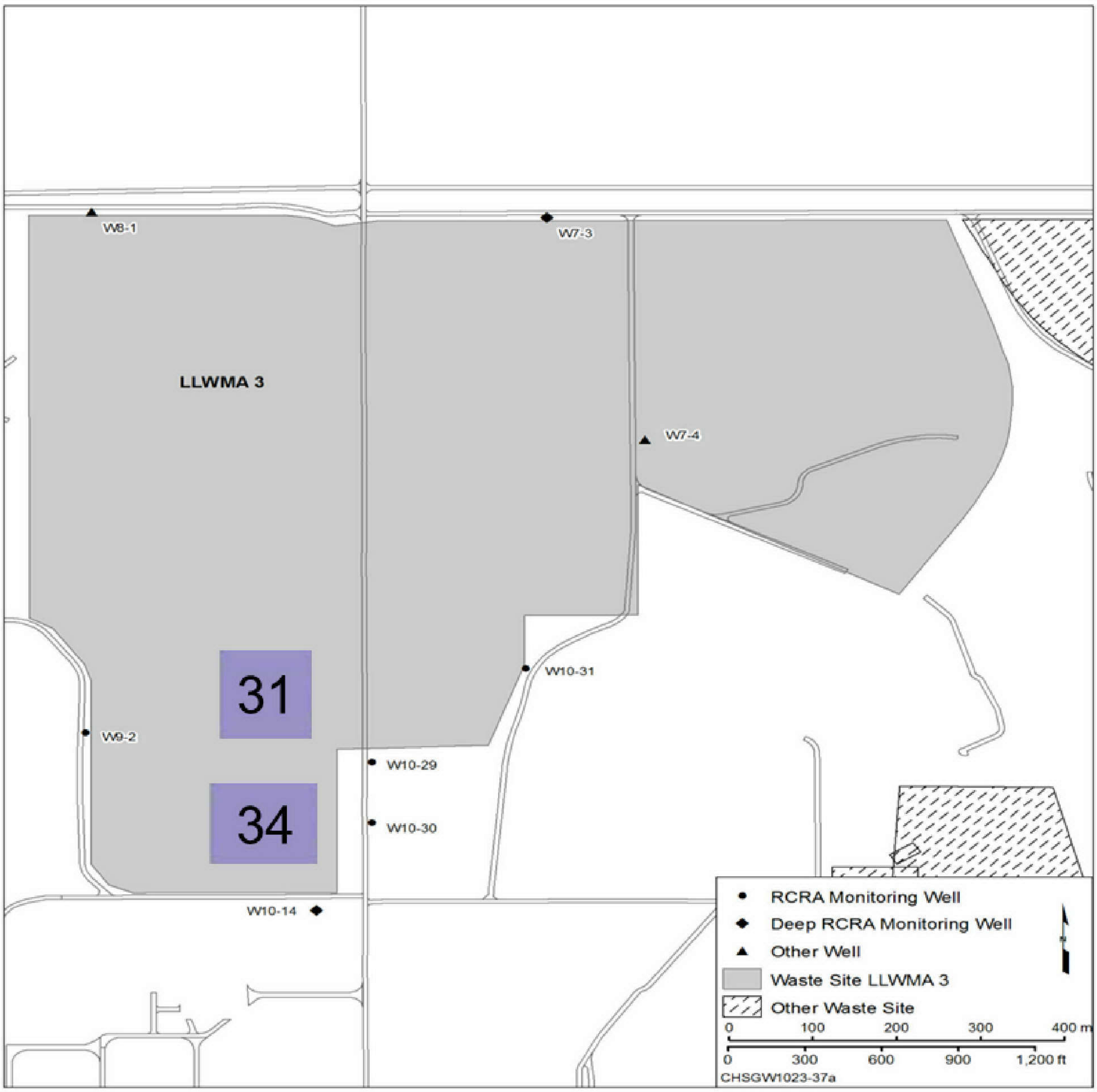

Figure 1-1. Map Showing Locations of RCRA Monitoring Wells at LLWMA-3

2 Background

Groundwater monitoring for LLBG Trenches 31 and 34 is currently performed through groundwater monitoring for LLWMA-3. The groundwater monitoring network for LLWMA-3 was developed as a result of previous investigations and data quality objective (DQO) equivalent studies. Groundwater monitoring is ongoing at LLBG Trenches 31 and 34 in accordance with interim status regulations. Near LLBG Trenches 31 and 34, groundwater pump and treat (P&T) technology is an element of the selected final remedy for the 200-ZP-1 Groundwater Operable Unit (OU). P&T is also an element of the interim groundwater remedy for the S-SX Tank Farms in the 200-UP-1 OU, located south of the 200-ZP-1 OU on the Hanford Site Central Plateau, near Richland, Washington. The groundwater extracted from the 200-ZP-1 and 200-UP-1 S-SX P&T remedies is ultimately combined and treated at a single facility referred to herein as the 200 West P&T treatment facility.

As a result of the impact of the groundwater P&T remedies on groundwater flow directions and rates, and the potential influence of P&T on the migration of potential releases from Trenches 31 and 34 within the LLWMA-3 boundary, the DQO process for these trenches included the use of groundwater modeling to evaluate the effects of groundwater extraction and treated water reinjection at monitoring locations (SGW-47729-VA, *Low-Level Burial Ground 3 Trenches 31 and 34 DQO Process*). Groundwater currently flows generally eastward-southeastward beneath LLWMA-3 and is affected by groundwater injection from the 200 West P&T, which started operating in July 2012. Two injection wells (299-W10-35 and 299-W10-36) are within the boundaries of LLWMA 3. Another injection well, 299-W6-14, is located east of the LLWMA.

The current LLWMA-3 monitoring network consists of one upgradient well (299-W9-2) and three downgradient wells (299-W10-29, 299-W10-30, and 299-W10-31), which are all screened at the top of the unconfined aquifer (Figure 2-1). The DQO process emphasized the location of the monitoring wells relative to the location of the 200-ZP-1 P&T remedy injection and extraction wells. This ECF presents additional calculations that consider the possible role of treated water reinjection at the 200-ZP-1 injection wells in detecting potential releases from LLBG Trenches 31 and 34 at existing and potential new monitoring wells.

2.1 Central Plateau Groundwater Model

DOE/RL-2007-28, *Feasibility Study Report for the 200-ZP-1 Operable Unit*, and DOE/RL-2007-33, *Proposed Plan for the Remediation of the 200-ZP-1 Groundwater Operable Unit*, for remediation of 200-ZP-1 OU, describe groundwater P&T as an element of the final remedy set forth in EPA et al., 2008, *Record of Decision, Hanford 200 Area 200-ZP-1 Operable Unit Superfund Site, Benton County, Washington*. The Central Plateau Groundwater Model (CPGWM), detailed in CP-47631, *Model Package Report: Central Plateau Groundwater Model Version 3.3*, is the principal computational tool used to design and evaluate the performance of the 200-ZP-1 and adjacent 200-UP-1 groundwater remedies. LLWMA-3 lies within the 200-ZP-1 OU and, consequently, also lies within the computational simulation domain of the CPGWM (Figure 2-2).

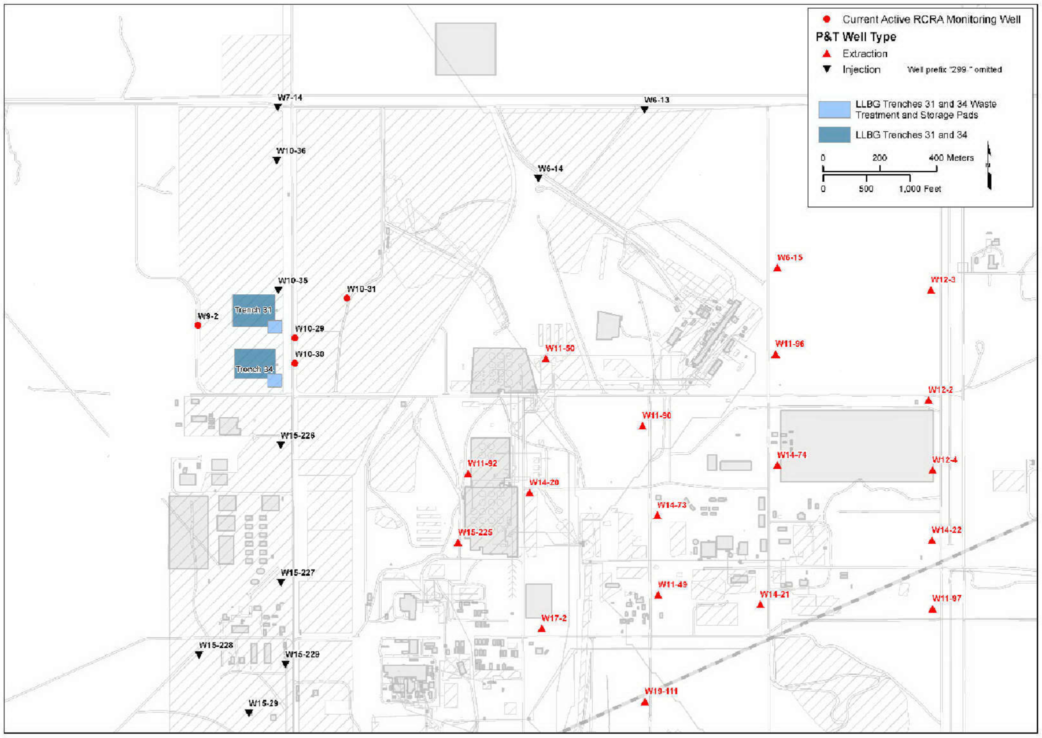

Figure 2-1. Map Showing Locations of RCRA Monitoring Wells and P&T Wells at LLWMA-3

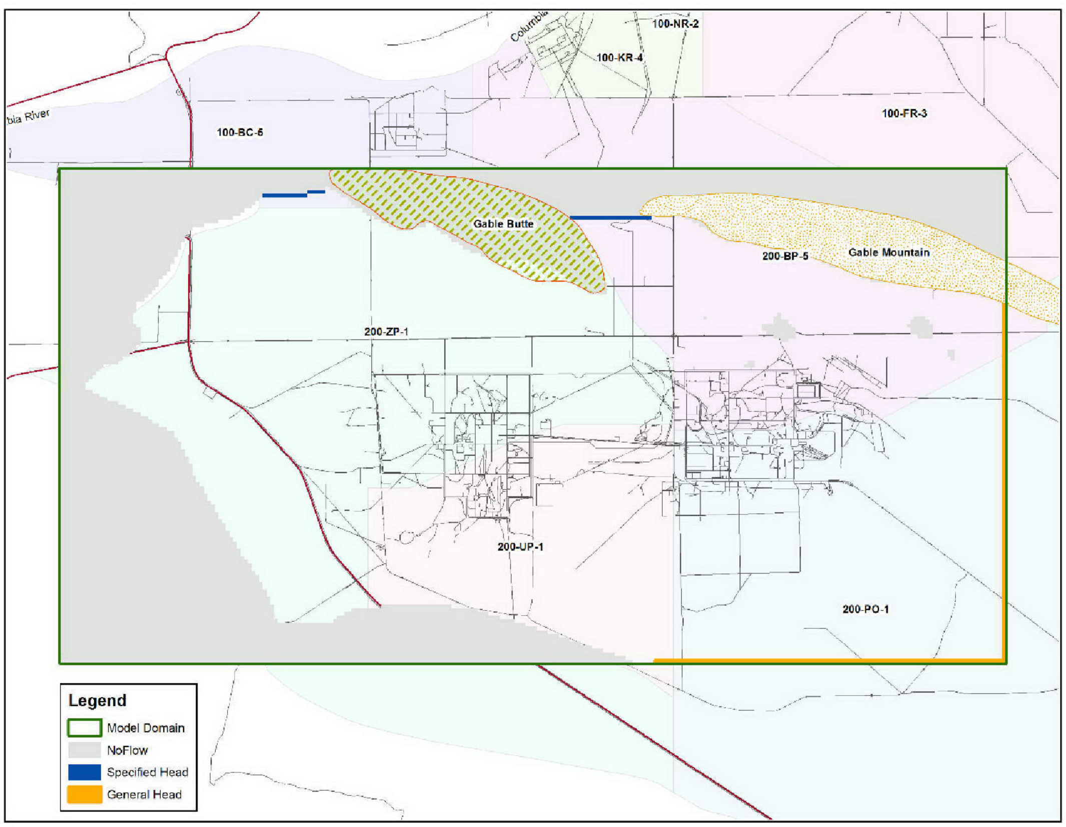

Figure 2-2. Groundwater Model Domain and Model Boundary Conditions

2.1.1 Central Plateau Groundwater Model History

During 2008, a groundwater flow and contaminant transport model was developed to support 200-ZP-1 OU remedy decisions. The first version of the model is described in DOE/RL-2008-56, *200 West Area Pre-Conceptual Design for Final Extraction/Injection Well Network: Modeling Analyses,* and DOE/RL-2007-33. DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*, discusses the plan and schedule for the design, installation, and operation of the remedy set forth in the 200-ZP-1 OU Record of Decision (EPA et al., 2008). DOE/RL-2009-38, *Description of Modeling Analyses in Support of the 200-ZP-1 Remedial Design/Remedial Action Work Plan*, presents the results of simulations completed to support the remedy design presented in the remedial design/remedial action work plan. During 2009 and 2010, the groundwater model was redeveloped, recalibrated, and reissued as the CPGWM via a series of model package reports.

2.1.2 Current Version

The most recent model package report describing the CPGWM was released in 2011 (CP-47631). The report describes the current version of the CPGWM used to support groundwater activities throughout the 200 West Area. Version 3.3 of the CPGWM simulates groundwater flow using the U.S. Geological Survey three-dimensional groundwater flow code, MODFLOW, which is discussed in the following documents:

- Harbaugh, 2005, *MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model – The Ground-Water Flow Process*
- Harbaugh and McDonald, 1996, *User's Documentation for MODFLOW-96, an Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model*
- Harbaugh et al., 2000, *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process*
- McDonald and Harbaugh, 1988, "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model"

Contaminant transport is simulated using the Modular 3-D Transport Multi-Species (MT3DMS) code (Zheng and Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*; Zheng, 2010, *MT3DMS v5.3 Supplemental User's Guide*). MT3DMS is a three-dimensional, multi-species transport model developed specifically for use with MODFLOW to simulate contaminant advection, dispersion, and chemical reactions in groundwater. MT3DMS was used to calculate the approximate directions and rates of migration of 200-ZP-1 and 200-UP-1 (S-SX) contaminants. The particle-tracking post-processor MODPATH (Pollock, 1994, *User's Guide for MODPATH/ MODPATH-PLOT, Version 3: A Particle Tracking Post-Processing Package for MODFLOW, the U.S. Geological Survey Finite-Difference Ground-Water Flow Model*) is used to compute pathlines based upon results obtained from the CPGWM groundwater flow simulations.

2.1.3 Use of the Central Plateau Groundwater Model for Low-Level Burial Ground Trenches 31 and 34

Use of the CPGWM model to support the preparation of SGW-59564 is summarized in this ECF. The assumptions and inputs for the calculations are discussed in Chapter 4, and the software used to complete the calculations is described in Chapter 5. Specific calculations are detailed in Chapter 6, and the results are presented in Chapter 7.

3 Calculation Methods

This chapter describes the calculation methods used. Simulations were conducted to evaluate the efficacy of the groundwater monitoring network to yield representative samples and detect significant increases in groundwater contamination that might occur from a potential release at LLBG Trenches 31 and 34 while reflecting the influence of the adjacent 200-ZP-1 injection wells.

3.1 Groundwater Flow Simulation

No changes were made to the fundamental structure of the CPGWM v3.3 that is detailed in CP-47631 before performing the simulations described in this ECF.

3.1.1 Time Discretization

Model time is discretized into stress periods and time steps. Changes in external forcing functions such as recharge or pumping typically occur by changing stress periods. Stress periods are divided into time steps, which allows for a more accurate discretization of the time derivative of the partial differential groundwater flow equation. The time discretization used for the simulations described herein was unchanged from the time discretization that was implemented during calendar year (CY) 2015, when the CPGWM was used to simulate current and future P&T operations in support of the annual groundwater P&T report for the 200-ZP-1 and 200-UP-1 OUs. The CPGWM time discretization is shown in Table 3-1 and is summarized as follows:

- A single steady-state stress period was selected to represent predevelopment conditions for a timeframe of approximately 274 years (unchanged from previous applications).
- Annual stress periods were used to simulate transient conditions during the period from 1944 through 2007.
- A refined discretization consisting of monthly stress periods was used for the period from 2008 through 2012 (1) to simulate operations of the interim P&T remedy, enhanced with the addition of well 299-W15-225 (which was the first P&T remedy well to be installed and operated); and (2) to provide appropriate temporal resolution for model validation during the final P&T remedy startup.

Table 3-1. CPGWM Temporal Discretization

Stress Period	Duration	This Application
Historical Model		
1	Approximately 274 years	Represents pre-development conditions
2 to 65	1944 to 2007	Yearly stress periods
66 to 113	2008 to 2011	Monthly stress periods
Predictive Model		
1 to 36	01/01/2012 to 12/31/2014	Monthly stress periods representing end of interim and startup of remedy (Phase II commences October 1, 2012)

Table 3-1. CPGWM Temporal Discretization

Stress Period	Duration	This Application
37	01/01/2015 to 05/31/2015	Single stress period (continuing Phase II of remedy)
38	06/01/2015 to 09/30/2015	Single stress period (continuing Phase II of remedy)
39	10/01/2015 to 09/30/2016	Single stress period (continuing Phase II, and commencing Phase III of remedy)
40	10/01/2016 to 09/30/2019	Single stress period (continuing Phase III of remedy)
41 to 43	10/01/2019 to 09/30/2034	5-year stress periods (continuing Phase III of remedy)
44	10/01/2034 to 09/30/2037	Single stress period (continuing Phase III of remedy)
45	10/01/2037 to 10/1/2137	100-year stress period

For the predictive simulations described in this ECF, model stress periods representing future conditions were discretized, as summarized in Table 3-1 and outlined as follows:

- The first 36 stress periods are monthly stress periods representing the end of interim remedy operations and startup of the final 200-ZP-1 P&T remedy.
- Stress period 37 is 6 months long, and stress period 38 is 4 months long, representing recent pumping conditions calculated as the average of the first 7 months of CY 2015.
- Stress periods 39 through 44 represent the simulation of the scenarios that were proposed for this monitoring evaluation. The scenarios were selected to provide a bounding set of conditions to support current monitoring well locations for Trenches 31 and 34, or to determine if adjustment to the monitoring network is needed.
- Stress period 45 is 100 years long and is used to simulate the period during which monitored natural attenuation (MNA) is the operating remedy.

3.1.2 Model Input Updates

The following two changes were made to CPGWM inputs prior to performing the simulations described in this ECF in order to update the CPGWM to reflect recent P&T operations:

- Updating well flow rates to actual rates recorded for extraction and injection wells through the end of July 2015
- Updating the external (lateral) boundary conditions

Because these updates comprise changes to the CPGWM inputs, they are further described in Section 4.2.

3.1.3 Groundwater Flow Model Calibration

The flow model component of the CPGWM was previously calibrated to groundwater-level data from 1944 through 2011 to provide correspondence between simulated and measured groundwater elevations (CP-47631). Since that time, the outputs of the CPGWM have been compared with measured groundwater elevations to ensure that the simulated values still reasonably correspond with measured data. Figure 3-1 depicts selected water-level hydrographs throughout the area illustrating correspondence between simulated and measured groundwater elevations at times after the calibration period.

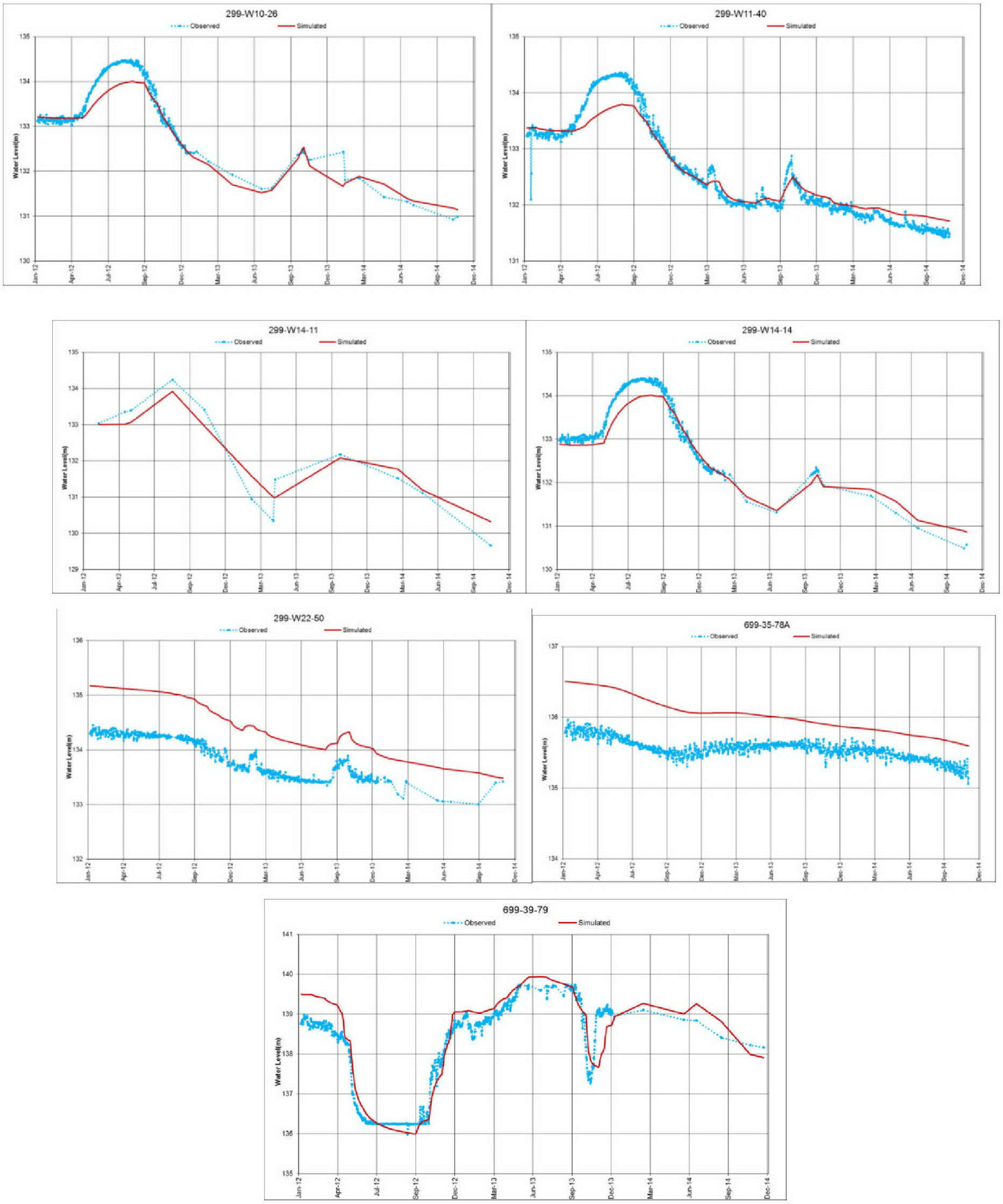

Figure 3-1. Selected Water-Level Hydrographs throughout the Study Area Illustrating the Correspondence Between Simulated and Measured Groundwater Elevations

3.1.4 Simulated Scenarios

Using the current version of the CPGWM, a series of groundwater flow simulations was performed to evaluate a range of possible operating conditions (i.e., predominantly alternate configurations of treated water reinjection) reflecting the potential range of influence that could result from alternate operation of the adjacent 200-ZP-1 injection wells. Table 3-2 identifies the simulation scenarios that were completed and provides a general description of each scenario. The scenarios were selected to provide a bounding set of conditions to evaluate current monitoring well locations for Trenches 31 and 34 and to assist in determining whether adjustment to the monitoring network is justified. Inputs for the simulations, including the actual simulated rate at each well, are detailed in Section 4.2. This table also lists the relative likelihood (in terms of percentages) of the alternate 200 West P&T system future operations scenarios, based on input from project scientists.

Table 3-2. Simulation Scenarios

Scenario	Sub-scenario	P&T System Capacity (gal/min)*	Description	Scenario Weight (%)
1	A	2,320	Current conditions.	74
1	B	2,320	Current, but with injection well 299-W10-35 operating at 50 percent.	10
1	C	2,320	Current, but with injection well 299-W10-35 not operating.	5
1	D	2,320	Current, but with injection well 299-W15-226 operating at 50 percent.	5
1	E	2,320	Current, but with injection well 299-W15-226 not operating.	5
1	F	2,320	Current, but with both injection wells 299-W10-35 and 299-W15-226 not operating.	1
2	A	2,500	2,500 gal/min, rates rebalanced. Injection wells 299-W10-35 and 299-W15-226 at current rates.	74
2	B	2,500	2,500 gal/min. Rates as per scenario 2A, except injection well 299-W10-35 operating at 50 percent; remainder rebalanced.	10
2	C	2,500	2,500 gal/min. Rates as per scenario 2A, except injection well 299-W10-35 not operating; remainder rebalanced.	5
2	D	2,500	2,500 gal/min. Rates as per scenario 2A, except injection well 299-W15-226 operating at 50 percent; remainder rebalanced.	5
2	E	2,500	2,500 gal/min. Rates as per scenario 2A, except injection well 299-W15-226 not operating; remainder rebalanced.	5
2	F	2,500	2,500 gal/min. Rates as per scenario 2A, except injection wells 299-W15-35 and 299-W15-226 not operating; remainder rebalanced.	1
3	A	0	System shutdown following active P&T.	

Notes: For dilution calculations, unit concentration released at injection wells correspond with initiation of each injection well (i.e., using actual dates/timing).

For release calculations, unit concentration released at each trench assumed a late 2015 release date.

* Scenario 1 pumping rate = 2,000 gal/min 200-ZP-1 + 320 gal/min S-SX= 2,320 gal/min; scenario 2 pumping rate = 2,180 gal/min 200-ZP-1 + 320 gal/min S-SX = 2,500 gal/min.

P&T = pump and treat

3.2 Particle-Tracking "Pathline" Calculations

For each case (A through F in scenarios 1 and 2), a series of particle-tracking calculations was completed as follows:

- Release particles at the water table from locations near injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226 and track them forward, to reflect reinjected water
- Release particles at the water table around the perimeter of Trenches 31 and 34 ("perimeter release") and track them forward, to reflect and encompass a potential release that reaches the water table
- Release particles in a 20 m diameter circle located at the low point of the leachate collections system in Trenches 31 and 34 ("focused release") and track them forward, to reflect and focus upon a potential release that reaches the water table

In all cases, particles were tracked through to the end of fiscal year (FY) 2037, which is the date when the 200-ZP-1 groundwater P&T remedy will cease operation. In each case, particle transport was simulated first using advection only, to illustrate general directions of likely movement and subsequently using both advection and dispersion, with the latter simulating the effect of mechanical dispersion of contaminants during transport in groundwater. Dispersion was simulated using a random-walk implementation option that is provided with the Hanford Site version of the MODPATH particle-tracking simulator developed by S.S. Papadopulos & Associates, Inc. (SSP&A) (Lichtner et al., 2002, "New form of dispersion tensor for axisymmetric porous media with implementation in particle tracking"; CHPRC-00261, *MODFLOW and Related Codes Acceptance Test Report;* SSP&A, 2015, *MODPATH-SSPA Build 8: Documentation of a Random-Walk Option for MODPATH v. 5*). As described in the software documentation (CHPRC-00261), for consistency, this random-walk module reads and uses the same dispersion inputs as the Hanford version of the transport simulator MT3DMS.

3.3 Estimated Dilution Calculations

For each case (A through F in scenarios 1 and 2), the potential effect of dilution resulting from the reinjection of treated water at the injection wells was evaluated using a "unit-plume" transport simulation approach. In this approach, a unit concentration (i.e., C = 1.0) is assumed to be injected or released continuously at a location of interest. This unit concentration can represent either a single contaminant, a combination of contaminants, or clean treated water; in either case, for purposes of this ECF, this is referred to as a "unit source." The ascribed value of 1.0 at the unit source denotes only that at the location of interest the water comprises 100 percent of the quantity of interest. As water migrates from the unit source, the effects of mixing and dispersion within the aquifer are simulated. As a result, over time and in space, the simulated concentration represents the fraction of the original water that was released or injected at the unit source location. For example, a concentration of 0.5 indicates that at that time and location the water comprises 50 percent of the unit source and 50 percent of the ambient groundwater.

These calculations can also be interpreted in terms of a dilution factor as follows:

- If the unit source represents a contaminant release, then the concentration at any point or time represents the factor by which the concentration at the source has reduced via the processes of advection, dispersion, and dilution.
- If the unit source represents treated water reinjection, then the concentration at any point or time represents the fraction of the water at that location that comprises reinjected treated water and how that fraction has reduced via the processes of advection, dispersion, and dilution

The potential dilution calculations were completed as follows:

- Release unit concentrations representing injected water from the same four injection wells (299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226) as considered for the particle-tracking calculations to simulate the reinjected water migration and transport through FY 2037.
- Release unit concentrations representing potential water table impacts below Trenches 31 and 34, as considered for the particle-tracking calculations to simulate the migration and transport of the potential release in groundwater through FY 2037.

In each case, outputs from the potential dilution calculations were prepared as follows:

- By contouring the simulated concentration at the water table throughout the 200 West Area
- By plotting the simulated concentration over time at selected spatial locations:

In the case of simulated water table releases, these are referred to as "release concentration breakthrough curves."

In the case of treated water reinjection, these are referred to as "treated water dilution curves."

4 Assumptions and Inputs

This chapter outlines the assumptions and inputs that underlie the calculations.

4.1 Assumptions

Assumptions used for groundwater flow modeling, particle tracking, and transport dilution modeling are discussed in the following subsections.

4.1.1 Groundwater Flow Modeling

The CPGWM is a calibrated and flow-conserved numerical simulator of groundwater and dissolved-phase in the Central Plateau. Since previous efforts were completed to calibrate the flow model parameters, the flow model outputs (i.e., heads and flow fields) in general correspond with measured data throughout the area of interest. However, the accuracy of simulated groundwater elevations and of inferences from those elevations (e.g., as flow rates and directions) are influenced by the structural accuracy of the CPGWM (i.e., how well the model represents actual physical conditions), the accuracy of the water-level data used for calibration, the magnitude and distribution of validation/calibration residuals, and other factors. These and other potential sources of error in the simulated outputs result in the simulations only approximating actual conditions. As such, the results are interpreted as reasonable approximations that provide value when interpreting the likely directions and rates of groundwater movement.

4.1.2 Particle Tracking

Particle tracking uses and therefore relies upon the outputs (i.e., heads and flows) computed using the CPGWM. As a result, the assumptions and limitations that underlie the groundwater flow component of the CPGWM are implicit in subsequent particle tracking. In addition, particle tracking considering advection only relies upon the assumption that the value of the mobile (effective) porosity of the aquifer, which is represented as a single best-estimate value, is representative of the bulk conservative transport of water and dissolved constituents. The particle tracking calculations that consider dispersion rely upon the assumption that the values of the dispersion coefficients simulated in the three principal directions (longitudinal, transverse, and vertical) are representative of physical processes that act to disperse dissolved constituents in groundwater at the scale of the simulations.

4.1.3 Transport Dilution Modeling

Transport modeling to assess the effect of mixing, recharge, and dispersion on dilution relies upon the accuracy of the outputs of the groundwater flow simulations, since the groundwater flow model forms the basis of the transport model and the accuracy of the parameters and other assumptions and inputs to the transport model. For purposes of the calculations presented in this ECF, it is also assumed that the transport parameters (i.e., for the mass-conserved advective/dispersive calculations, these parameters are limited to mobile [effective] porosity and dispersion) reasonably describe the dominant processes leading to the mixing of water from various sources with groundwater present in the subsurface.

4.2 Input Data

This section summarizes input that is specific to the calculations presented in this ECF. Inputs to the CPGWM that do not change for these calculations (e.g., the structure of the CPGWM) are not discussed. The principal inputs to the calculations completed to evaluate the monitoring network for LLBG Trenches 31 and 34 are (1) the assumed extraction and injection rates at P&T wells, and (2) the assumed transport parameters, which are described in the following subsections.

4.2.1 Extraction and Injection Rates

Representative flow rates for each of the 200 West P&T extraction and injection wells through September 2015 are summarized in Table 4-1 (note that rates for August and September were based upon data available from January through July). Figure 4-1 depicts average pumping rates for the period of January 1 through July 31, 2015, for the 200 West P&T. In the first two quarters of CY 2015, the combined 200 West P&T operated at an average combined rate of about 7,300 L/min (1,930 gal/min). Simulated flow rates at each extraction and injection well for each of the predictive scenarios are listed in Table 4-2.

4.2.2 Transport Properties

Transport parameters used in the calculations presented in this ECF are unchanged from the transport parameters used in calculations for previous annual P&T reports. However, since these parameters are fundamental to the calculations, they are listed in Table 4-3 for completeness.

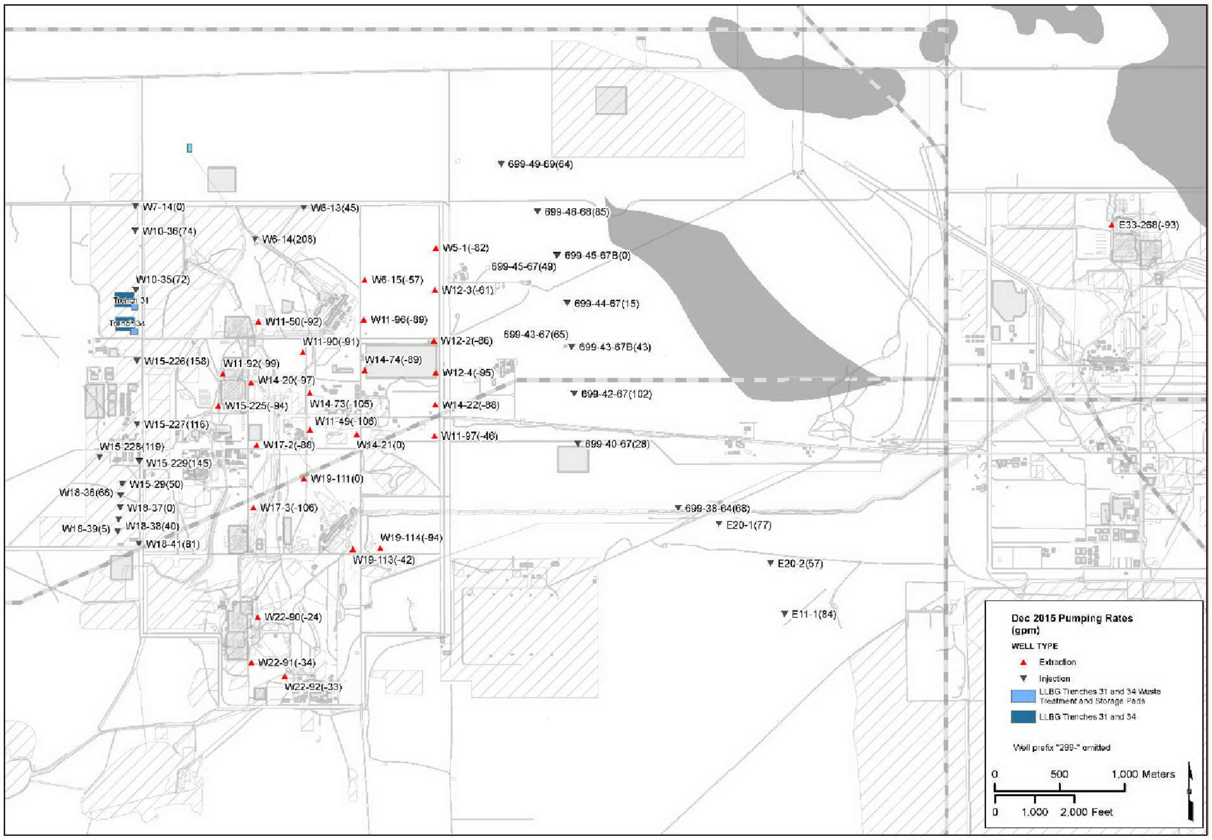

Figure 4-1. Average Pumping Rates for 200 West P&T Wells, January Through July 2015

Table 4-1. Historical Groundwater Extraction and Injection Rates for 200-ZP-1 and 200-UP-1/S-SX P&T Remedies, January 2012 Through September 2015

Model Stress Period		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Well ID	Well Name	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-July 2015	Aug-Sep 2015
YJ-04	299-W10-35	0	0	0	0	0	0	4	19	6	56	92	92	101	93	97	152	196	205	169	148	56	135	138	128	146	138	169	187	177	159	96	140	122	133	156	158	116	116
YJ-03	299-W10-36	0	0	0	0	0	0	4	16	5	49	79	82	89	83	86	126	160	158	135	74	84	90	148	127	150	90	87	204	124	117	121	102	116	110	116	104	94	94
	299-W11-45	-6	-8	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W11-46	-9	-13	-18	-18	-15	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-12	299-W11-49	0	0	0	0	0	0	-4	-23	-11	-48	-67	-77	-81	-75	-77	-101	-127	-111	-95	-95	-96	-87	-79	-79	-78	-79	-86	-89	-105	-111	-126	-106	-78	-117	-117	-118	-127	-127
YE-06	299-W11-50	0	0	0	0	0	0	0	0	-12	-50	-83	-96	-101	-91	-97	-45	-112	-109	-108	-85	-105	-43	-103	-90	-81	-115	-116	-119	-108	-115	-119	-112	-110	-112	-110	-107	-110	-110
YE-07	299-W11-90	0	0	0	0	0	0	0	-4	-15	-56	-89	-95	-98	-92	-98	-132	-113	-111	-109	-97	-114	-56	-103	-110	-111	-138	-137	-149	-109	-111	-100	-99	-95	-105	-106	-100	-110	-110
YE-16	299-W11-92	0	0	0	0	0	0	0	-2	-9	-53	-81	-94	-102	-93	-101	-126	-113	-110	-109	-101	-90	0	-102	-129	-137	-137	-137	-139	-116	-112	-100	-92	-88	-109	-110	-104	-111	-111
YE-08	299-W11-96	0	0	0	0	0	0	0	-7	-22	-41	-58	-68	-95	-90	-82	-109	-128	-95	-62	-57	-64	-109	-83	-81	-78	-70	-88	-101	-84	-91	-96	-38	0	-100	-101	-83	-95	-95
YE-05	299-W12-2	0	0	0	0	0	0	0	-18	-8	-52	-65	-81	-97	-94	-97	-117	-137	-95	-63	-57	-23	-80	-88	-86	-79	-85	-93	-112	-93	-100	-102	-93	-5	-129	-118	-102	-109	-109
YE-18	299-W12-3	0	0	0	0	0	0	-3	-21	-8	-44	-60	-92	-98	-94	-97	-119	-135	-95	-72	-64	-100	-109	-87	-85	-79	-80	-95	-98	-88	-89	-86	-86	-57	-103	-93	-80	-86	-86
YE-19	299-W12-4	0	0	0	0	0	0	-4	-23	-8	-49	-69	-94	-99	-95	-97	-112	-131	-95	-61	-102	-88	-79	-87	-124	-136	-86	-120	-135	-97	-121	-114	-103	-97	-144	-123	-105	-120	-120
YE-02	299-W14-20	0	0	0	0	0	0	0	-5	-14	-54	-87	-96	-101	-91	-96	-119	-111	-109	-107	-97	-87	0	-100	-103	-104	0	0	0	-65	-99	-119	-112	-110	-111	-109	-104	-110	-110
YE-15	299-W14-21	0	0	0	0	0	0	-3	-20	-10	-44	-60	-62	-82	-74	-78	-101	-108	-102	-95	-89	-95	-34	-79	-100	-109	-107	-107	-109	-96	-97	-99	-89	-79	-99	-100	-101	-107	-107
YE-20	299-W14-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-41	-56	-73	-73
YE-03	299-W14-73	0	0	0	0	0	0	-2	-23	-12	-46	-55	-67	-79	-75	-77	-104	-133	-113	-99	-73	-1	-69	-80	-81	-80	-79	-86	-90	-84	-93	-89	-82	-79	-127	-144	-133	-126	-126
YE-04	299-W14-74	0	0	0	0	0	0	0	0	0	0	-55	-91	-95	-90	-83	-110	-110	-104	-94	-97	-110	-111	-86	-95	-90	-79	-107	-127	-99	-111	-94	-93	-76	-123	-129	-125	-130	-130
	299-W15-1	-10	-11	-9	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W15-11	-10	-10	-10	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-01	299-W15-225	-249	-250	-247	-242	-11	0	0	0	-3	-28	-50	-69	-68	-68	-68	-83	-99	-94	-84	-68	-91	-86	-79	-81	-81	-80	-87	-90	-90	-93	-98	-90	-80	-99	-99	-93	-97	-97
YJ-05	299-W15-226	0	0	0	0	0	0	5	19	7	69	105	102	114	104	109	176	228	234	201	186	72	85	282	159	176	172	186	123	197	216	223	217	191	220	238	223	234	234
YJ-06	299-W15-227	0	0	0	0	0	0	4	15	4	50	80	83	90	84	87	127	158	158	130	135	141	84	211	221	262	251	255	239	155	167	136	103	90	105	107	57	106	106
YJ-07	299-W15-228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	153	153
YJ-24	299-W15-229	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	93	150	150
YJ-18	299-W15-29	135	129	118	91	4	0	0	0	0	1	12	131	77	75	78	108	133	122	135	136	140	78	23	1	49	42	57	33	40	60	55	44	42	45	46	43	33	33
	299-W15-34	-11	-11	-10	-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W15-35	-13	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W15-43	-12	-12	-12	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W15-45	-14	-14	-14	-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W15-46	-43	-43	-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	299-W15-7	-5	-5	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-10	299-W17-2	0	0	0	0	0	0	-2	-17	-9	-38	-57	-66	-84	-77	-79	-91	-93	-91	-87	-51	0	-63	-81	-81	-80	-79	-86	-90	-85	-91	-99	-89	-78	-95	-95	-90	-88	-88
YE-09	299-W17-3	0	0	0	0	0	0	-3	-20	-10	-45	-68	-78	-83	-75	-78	-102	-124	-112	-97	-87	-96	-44	-75	-80	-77	-96	-90	-96	-92	-82	-100	-86	-71	-109	-114	-113	-123	-123
YJ-19	299-W18-36	84	81	76	64	3	0	0	0	0	21	69	72	77	75	77	86	92	103	93	87	85	70	36	80	88	94	96	100	65	90	101	89	79	81	88	82	61	61
YJ-20	299-W18-37	1	1	1	1	0	0	0	0	0	16	67	71	75	45	74	66	70	80	72	66	54	31	54	74	42	17	22	0	20	28	30	22	20	0	0	0	0	0
YJ-21	299-W18-38	68	66	62	53	3	0	0	0	0	13	59	65	71	76	62	29	38	66	43	21	8	24	64	91	97	100	98	73	60	87	84	69	55	58	57	52	51	51
YJ-22	299-W18-39	69	67	63	54	4	0	0	0	0	6	56	63	69	72	64	49	62	66	46	35	10	17	49	68	73	66	48	64	51	77	73	62	38	56	55	51	25	25

Table 4-1. Historical Groundwater Extraction and Injection Rates for 200-ZP-1 and 200-UP-1/S-SX P&T Remedies, January 2012 Through September 2015

Model Stress Period		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Well ID	Well Name	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-July 2015	Aug-Sep 2015
YE-21	299-W22-90	0	0	0	0	0	0	0	-1	-3	-10	-17	-23	-22	-23	-23	-22	-23	-23	-23	-22	-14	-3	-23	-23	-22	-23	-22	-23	-24	-20	-17	-16	-16	-17	-17	-16	-24	-24
YE-22	299-W22-91	0	0	0	0	0	0	0	-1	-3	-11	-20	-23	-33	-20	-27	-34	-35	-35	-35	-34	-21	-3	-25	-24	-35	-35	-35	-35	-35	-36	-35	-33	-33	-35	-35	-32	-35	-35
YE-23	299-W22-92	0	0	0	0	0	0	0	-1	-3	-10	-19	-14	-23	-23	-24	-23	-24	-24	-24	-23	-14	-3	-24	-24	-24	-24	-24	-24	-24	-29	-35	-33	-33	-35	-35	-32	-35	-35
YE-17	299-W5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-41	-56	-60	-60
YJ-01	299-W6-13	0	0	0	0	0	0	5	25	7	82	125	118	133	120	127	221	296	277	49	90	119	51	97	82	46	102	102	99	73	103	111	87	94	63	10	43	63	63
YJ-02	299-W6-14	0	0	0	0	0	0	4	18	6	55	88	89	97	90	93	143	178	177	147	82	145	111	163	173	207	204	131	182	243	241	276	211	103	318	298	242	197	197
YE-14	299-W6-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-50	-50
YJ-15	699-40-67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	134	127	113	113
YJ-14	699-42-67	0	0	0	0	0	0	0	8	51	87	69	114	150	144	138	111	112	21	101	109	115	81	74	50	42	16	105	80	96	95	90	128	116	107	117	116	108	108
YJ-13	699-43-67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-17	699-43-67B	0	0	0	0	0	0	0	11	50	93	72	117	145	139	138	118	85	14	72	67	52	47	56	23	3	48	50	53	41	59	54	47	42	4	40	30	127	127
YJ-12	699-44-67	0	0	0	0	0	0	0	5	51	80	71	113	147	144	153	122	109	20	75	78	107	79	60	49	33	27	43	59	43	43	84	61	47	36	45	43	35	35
YJ-11	699-45-67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	145	110	85	99	116	113	84	80	94	57	120	107	87	84	84
YJ-10	699-45-67B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	50	20	16	36	21	0	35	8	0	3	8	5	2	2
YJ-23	699-46-68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	136	134	97	97
YJ-09	699-49-69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	81	83	90	64	64
YE-11	299-W19-111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-13	299-W11-97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-25	299-W19-113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-26	299-W19-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YE-27	299-E33-268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-08	299-W18-41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	33
YJ-16	699-38-64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-25	299-W7-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-26	299-E20-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-27	299-E20-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-28	299-E11-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Extraction and injection rates are shown in gallons per minute (gal/min).

Table 4-2. Predicted Groundwater Extraction and Injection Rates for 200-ZP-1 and 200-UP-1/S-SX P&T Remedies for Out-Year Simulations for Each Simulated Scenario

Stress Periods		39 through 44 (10/01/2015 through 09/30/2037)												45 (10/01/2037 through 09/30/2137)
ID	Name	Scenario 1-A	Scenario 1-B	Scenario 1-C	Scenario 1-D	Scenario 1-E	Scenario 1-F	Scenario 2-A	Scenario 2-B	Scenario 2-C	Scenario 2-D	Scenario 2-E	Scenario 2-F	All Scenarios
YE-01	299-W15-225	-95	-95	-95	-95	-95	-95	-110	-110	-110	-110	-110	-110	0
YE-02	299-W14-20	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	0
YE-03	299-W14-73	-125	-125	-125	-125	-125	-125	-140	-140	-140	-140	-140	-140	0
YE-04	299-W14-74	-120	-120	-120	-120	-120	-120	-125	-125	-125	-125	-125	-125	0
YE-05	299-W12-2	-105	-105	-105	-105	-105	-105	-120	-120	-120	-120	-120	-120	0
YE-06	299-W11-50	-110	-110	-110	-110	-110	-110	-115	-115	-115	-115	-115	-115	0
YE-07	299-W11-90	-110	-110	-110	-110	-110	-110	-140	-140	-140	-140	-140	-140	0
YE-08	299-W11-96	-95	-95	-95	-95	-95	-95	-100	-100	-100	-100	-100	-100	0
YE-09	299-W17-3	-120	-120	-120	-120	-120	-120	-110	-110	-110	-110	-110	-110	0
YE-10	299-W17-2	-85	-85	-85	-85	-85	-85	-100	-100	-100	-100	-100	-100	0
YE-11	299-W19-111	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	0
YE-12	299-W11-49	-125	-125	-125	-125	-125	-125	-125	-125	-125	-125	-125	-125	0
YE-13	299-W11-97	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	0
YE-14	299-W6-15	-50	-50	-50	-50	-50	-50	-100	-100	-100	-100	-100	-100	0
YE-15	299-W14-21	-105	-105	-105	-105	-105	-105	-100	-100	-100	-100	-100	-100	0
YE-16	299-W11-92	-110	-110	-110	-110	-110	-110	-100	-100	-100	-100	-100	-100	0
YE-17	299-W5-1	-60	-60	-60	-60	-60	-60	-70	-70	-70	-70	-70	-70	0
YE-18	299-W12-3	-85	-85	-85	-85	-85	-85	-100	-100	-100	-100	-100	-100	0
YE-19	299-W12-4	-120	-120	-120	-120	-120	-120	-115	-115	-115	-115	-115	-115	0
YE-20	299-W14-22	-70	-70	-70	-70	-70	-70	-100	-100	-100	-100	-100	-100	0
YE-21	299-W22-90	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	0
YE-22	299-W22-91	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	0
YE-23	299-W22-92	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	0
YE-25	299-W19-113	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	0
YE-26	299-W19-114	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	0
YE-27	299-E33-268	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	0
YJ-01	299-W6-13	60	60	60	60	60	60	60	60	60	65	75	85	0
YJ-02	299-W6-14	190	190	190	190	200	200	200	200	200	200	220	250	0
YJ-03	299-W10-36	90	110	125	120	150	200	95	118	130	110	130	130	0
YJ-04	299-W10-35	110	55	0	140	150	0	115	57	0	150	160	0	0
YJ-05	299-W15-226	210	220	230	105	0	0	230	235	235	115	0	0	0
YJ-06	299-W15-227	100	115	130	120	140	160	100	130	175	150	170	200	0
YJ-07	299-W15-228	150	150	150	150	150	150	140	140	140	150	150	160	0
YJ-08	299-W18-41	30	30	30	30	30	30	40	40	40	40	40	40	0
YJ-09	699-49-69	60	60	60	60	60	60	65	65	65	65	65	65	0
YJ-10	699-45-67B	5	5	5	5	5	5	10	10	10	10	10	10	0
YJ-11	699-45-67	80	80	80	80	80	90	80	80	80	80	80	90	0

Table 4-2. Predicted Groundwater Extraction and Injection Rates for 200-ZP-1 and 200-UP-1/S-SX P&T Remedies for Out-Year Simulations for Each Simulated Scenario

Stress Periods		39 through 44 (10/01/2015 through 09/30/2037)												45 (10/01/2037 through 09/30/2137)
ID	Name	Scenario 1-A	Scenario 1-B	Scenario 1-C	Scenario 1-D	Scenario 1-E	Scenario 1-F	Scenario 2-A	Scenario 2-B	Scenario 2-C	Scenario 2-D	Scenario 2-E	Scenario 2-F	All Scenarios
YJ-12	699-44-67	30	30	30	30	30	30	80	80	80	80	80	80	0
YJ-13	699-43-67	50	50	50	50	50	50	50	50	50	50	50	50	0
YJ-14	699-42-67	100	100	100	100	100	120	110	110	110	110	110	130	0
YJ-15	699-40-67	110	110	110	110	110	140	110	110	110	110	110	140	0
YJ-16	699-38-64	50	50	50	50	50	50	50	50	50	50	50	50	0
YJ-17	699-43-67B	100	100	100	100	100	100	100	100	100	100	100	100	0
YJ-18	299-W15-29	30	30	30	30	30	30	30	30	30	30	35	35	0
YJ-19	299-W18-36	60	60	60	60	60	60	65	65	65	65	65	65	0
YJ-20	299-W18-37	0	0	0	0	0	0	0	0	0	0	0	0	0
YJ-21	299-W18-38	50	50	50	50	50	50	50	50	50	50	50	50	0
YJ-22	299-W18-39	20	20	20	20	20	20	30	30	30	30	30	30	0
YJ-23	699-46-68	90	90	90	90	90	90	100	100	100	100	100	100	0
YJ-24	299-W15-229	120	120	120	145	145	145	140	140	140	140	150	170	0
YJ-25	299-W7-14	125	135	150	125	160	180	150	150	150	150	170	170	0
YJ-26	299-E20-1	100	100	100	100	100	100	100	100	100	100	100	100	0
YJ-27	299-E20-2	100	100	100	100	100	100	100	100	100	100	100	100	0
YJ-28	299-E11-1	100	100	100	100	100	100	100	100	100	100	100	100	0
Total Extraction		**-2,320**	**-2,320**	**-2,320**	**-2,320**	**-2,320**	**-2,320**	**-2,500**	**-2,500**	**-2,500**	**-2,500**	**-2,500**	**-2,500**	**0**
Total Injection		**2,320**	**2,320**	**2,320**	**2,320**	**2,320**	**2,320**	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**	**0**
Total Extraction S-SX		**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**-320**	**0**
Total Extraction 200 West		**-2,000**	**-2,000**	**-2,000**	**-2,000**	**-2,000**	**-2,000**	**-2,180**	**-2,180**	**-2,180**	**-2,180**	**-2,180**	**-2,180**	**0**

Note: Extraction and injection rates are shown in gallons per minute (gal/min).

Table 4-3. Transport Properties Assumed for Dilution Calculations Using the CPGWM

Assumed Properties for Purposes of Conservative Dilution Calculations					
Distribution Coefficient (mL/g)	**Half-Life (yr)**	**Half-Life (day)**	**Degradation Rate (one/day)**	**Reference for Distribution Coefficient**	**Reference for Degradation Rate**
0.00+00	None assumed	None assumed	None assumed	None assumed	None assumed
Aquifer Dependent Transport Parameter Values for the Central Plateau Model					
Property	**Value**	**Comments**			
Effective porosity	0.15	Approximate central value (Table D-2 of DOE/RL-2007-28)			
Longitudinal dispersivity	3.5 m	Introduced for stability of the transport calculations using recommendation from MT3D manual (Zheng and Wang, 1999)			
Transverse dispersivity	0.7 m	20 percent of longitudinal (DOE/RL-2008-56)			
Vertical dispersivity	0.0 m	DOE/RL-2008-56			
Molecular diffusion constant	0.0 m^2/d	Negligible term			

References: DOE/RL-2007-28, *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit*.

DOE/RL-2008-56, *200 West Area Pre-Conceptual Design for Final Extraction/Injection Well Network: Modeling Analyses*.

PNNL-18564, *Selection and Traceability of Parameters to Support Hanford-Specific RESRAD Analyses: Fiscal Year 2008 Status Report*.

Zheng and Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*.

5 Software Applications, Descriptions, Installation and Checkout, and Statements of Validity

Software use for this calculation was in accordance with PRC-PRO-IRM-309, *Controlled Software Management*.

5.1 Approved Software

The software used to perform the calculations for this ECF was approved and is compliant with PRC-PRO-IRM-309. The software is managed under the following documents consistent with PRC-PRO-IRM-309:

- CHPRC-00257, Rev. 1, *MODFLOW and Related Codes Functional Requirements Document*
- CHPRC-00258, Rev. 4, *MODFLOW and Related Codes Software Management Plan*
- CHPRC-00259, Rev. 3, *MODFLOW and Related Codes Software Test Plan*
- CHPRC-00260, Rev. 8, *MODFLOW and Related Codes Requirements Traceability Matrix*
- CHPRC-00261, Rev. 8, *MODFLOW and Related Codes Acceptance Test Report*

CHPRC-00258 distinguishes between safety software and support software based on whether the software managed calculates reportable results or provides run support, visualization, or other similar functions. Brief descriptions of the software are provided in the following discussion.

5.2 Descriptions

MODFLOW, MT3DMS, and MODPATH software that were used for the calculations in this ECF are described in the following subsections.

5.2.1 MODFLOW (Controlled Calculation Software)

- **Software title:** MODFLOW-2000 (Harbaugh et al., 2000); solves transient groundwater flow equations using the finite-difference discretization technique.
- **Software version:** Version 1.19.01, modified by SSP&A to address dry cell issues and to use the Orthomin solver (Vinsome, 1976, "ORTHOMIN, an iterative method for solving sparse banded sets of simultaneous linear equations"); approved as CH2M HILL Plateau Remediation Company (CHPRC) Build 7 using a version of the executable "mf2k-mst-chprc07dpv.exe" compiled to default double precision for real variables and optimized for speed.
- **Hanford Information Systems Inventory (HISI) identification number:** 2517 (safety software, graded Level C).
- **Workstation type and property number (from which software is run):** SSP&A, FE449.

5.2.2 MT3DMS (Controlled Calculation Software)

- **Software title:** MT3DMS (Zheng and Wang, 1999; Zheng, 2010).
- **Software version:** Version 5.3, modified by SSP&A to address dry cell issues; approved as CHPRC Build 7 using a version of the executable "mt3d-mst-chprc07dpv.exe" compiled to default double precision for real variables and optimized for speed.
- **HISI identification number:** 2518 (safety software, graded Level C).
- **Workstation type and property number (from which software is run):** SSP&A, FE449.

5.2.3 MODPATH (Controlled Calculation Software)

- **Software title:** MODPATH (Pollock, 1994). A particle-tracking post-processor developed for use with the MODFLOW codes; used to evaluate the approximate directions and rates of groundwater flow and the approximate extent of hydraulic capture developed by proposed P&T well configurations.
- **Software version:** Version 5, modified by SSP&A to address dry cell issues; approved as CHPRC Build 8 using executable "modpath-chprc08.exe".
- **Workstation type and property number (from which software is run):** SSP&A, FE449.

5.3 Support Software

The software programs discussed in the following subsections are classified as support software.

5.3.1 MODFLOW Suite Support Software

- **Groundwater Vistas[1]:** (Rumbaugh and Rumbaugh, 2011, *Guide to Using Groundwater Vistas*) Provided graphical tools used for model quality assurance and model input/output review.
- **ArcGIS[2]:** (Mitchell, 1999, *The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns & Relationships*) Provided visualization tool for assessing simulated plume distributions, identifying extraction/injection well coordinates, and mapping auxiliary data.

5.4 Software Installation and Checkout

Safety software is checked out in accordance with procedures specified in CHPRC-00258. Executables are obtained from the CHPRC software owner (who maintains the configuration-managed copies in MKS Integrity), and installation tests identified in CHPRC-00259 are performed and successful installation confirmed. Software installation and checkout forms are required and must be approved for installations used to perform model runs. Approved users are registered in HISI for safety software.

5.4.1 Statement of Valid Software Application

The software identified previously was used consistent with intended use for CHPRC, as identified in CHPRC-00257, and is a valid use of this software for this application. The software was used within its limitations, as identified in CHPRC-00257.

6 Calculations

This chapter describes the calculations that were made.

6.1 Groundwater Flow Modeling and Particle Tracking

The following steps were used to develop the necessary input files, perform the calculations, and post-process the outputs to produce the figures presented in this ECF:

1. An input file for the MODFLOW Multi-Node Well Package for each subscenario was constructed to reflect the spatial and temporal configuration of the well operations. Groundwater extraction rates used to generate this input file through December 2014 are reported in the Environmental Model Management Archive (EMMA), the model configuration management system required under CHPRC-00805, Rev. 0 (*Quality Assurance Project Plan for Modeling*), within the EMMA data archive and accompanying documentation EMDT-ST-004, *Historical Pumping Rates 200 West Area, Electronic Modeling Data Transmittal – Boundary Condition (Historical Pumping Rates)*. This EMMA data archive will be updated to reflect rates through December 2015 as part of the CY 2015 annual P&T analyses. Assumed future pumping rates for each individual subscenario were developed in collaboration with CHPRC and are listed in Table 4-2.
2. The CPGWM flow model was executed to obtained simulated hydraulic head distributions, as well as the accessory outputs needed for particle tracking (MODPATH) and dilution/transport (MT3DMS) calculations.
3. For the potential waste site "perimeter release" scenarios, input files for the particle-tracking analyses were constructed, including assigning particle starting locations around the perimeter of LLBG

[1] Groundwater Vistas™ is a trademark of Environmental Simulations Incorporated, Reinholds, Pennsylvania.

[2] ArcGIS is a trademark, registered trademark or service mark of ESRI, Redlands, California.

Trenches 31 and 34. Particles were released at the water table to reflect a potential water table impact. In these cases the release time corresponds to the start of FY 2015, representing a "current" release.

4. For the potential waste site "focused release" scenarios, input files for the particle-tracking analyses were constructed, including assigning particle starting locations throughout a 20 m diameter circle located at the low point of the leachate collections system within Trenches 31 and 34. Particles were released at the water table to reflect a potential water table impact. In these cases, the initial release time for scenarios 1 and 2 corresponds to the start of FY 2015, representing a "current" release, however, in this case particles were then released from the same location every year until 2037, when the P&T system operation ends. For scenario 3A, since there is much less variability in the flow field following cessation of the P&T system operation; particles were initially released at the end of FY 2037 and were then released every 5 years thereafter.

5. For the reinjected water assessment scenarios, input files for the particle-tracking analyses were constructed, including assigning particle starting locations along a 100 m (328 ft) diameter circle around injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226. Particles were released at the water table to mimic the movement of reinjected water near the water table. In these cases, the release time corresponds to the CY 2012 startup of the 200 West P&T.

6. The particle-tracking program MODPATH was executed to track the particles, and the results were post-processed and superimposed upon figures that included the extraction, injection, and monitoring well locations to determine if monitoring locations lie in the migration pathway of any potential releases from the trenches, and if monitoring locations lie in the migration pathway of reinjected water.

To simulate dispersion with particle tracking, the random-walk particle tracking option implemented within MODPATH was used. As described in the software documentation (CHPRC-00261), for consistency, this random-walk module reads and uses the same dispersion inputs as the Hanford Site version of the transport simulator MT3DMS. In the majority of the map-based (spatial) figures presented in Chapter 7, the colors of the particle pathlines typically represent the relative time of travel from the date of release and corresponds with the time scale provided in the figure.

In the case of the focused release tracking scenarios, the objective is to identify areas of the aquifer where a potential release that impacts the water table beneath the low point of the leachate collections system within Trenches 31 and 34 would be most likely to migrate and be detectable. To prepare a map illustrating the results of these calculations on a finer spatial resolution than the discretization of the CPGWM simulation grid, the "relative detectability" was calculated as follows:

- 233 particles are released annually within the 20 m circle according to list item (4) above, resulting in a total of 5,166 particles
- A refined "calculation subgrid" was defined comprising 20 m by 20 m cells, resulting in 25 calculation cells within each CPGWM simulation cell
- The relative detectability was determined for each cell of the calculation subgrid by calculating, for each scenario, the number of released particles that traversed each calculation subgrid cell, and then

computing a weighted sum of these counts resulting in a value lying between zero (0) and one (1) for each calculation subgrid cell, as follows:

$$RD = \frac{1}{MNP} \sum_{1}^{n} P_i N_i$$

where:

RD	=	relative detectability (ranging from zero to one)
MNP	=	maximum number of particles that traversed any subgrid cell in all scenarios
P_i	=	ascribed weight or probability of subscenario *i* (as listed in Table 3-2)
N_i	=	number of particles that traversed the calculation subgrid cell during subscenario *i*
n	=	total number of subscenarios within the simulated scenario (i.e., 6, as listed in Table 3-2).

These calculations were made using the capabilities of the ArcGIS support software.

6.2 Transport (Dilution) Modeling

To evaluate the efficiency of the current LLWMA-3 groundwater monitoring network at detecting potential releases from the LLBG Trenches 31 and 34, two distinct yet complementary transport simulations were performed:

- Simulation of treated water reinjection using the unit source approach to represent the water reinjected at injection wells
- Simulation of a potential release that impacts the water table below Trenches 31 and 34 using the unit-source approach to represent the water table impact and subsequent migration from LLBG Trenches 31 and 34

The following steps were used to develop the necessary input files, perform the calculations, and post-process the outputs to develop spatial maps and also time-series plots depicting relative release concentrations over time in the case of simulated water table releases and relative treated water dilution concentrations in the case of treated water reinjection:

1. For the potential water table release evaluations, the MT3D Sink/Source Mixing (SSM) Package was prepared to simulate constant concentration sources representing potential contaminant leaks that impact the water table using constant unit concentrations at Trenches 31 and 34. The unit concentrations were assumed to be released at the start of FY 2015.
2. For the reinjected water evaluations, the MT3D SSM Package was prepared to simulate constant-concentration sources representing the injection of a unit concentration at four 200 West P&T injection wells: 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226. The unit concentration was released at each injection well corresponding with the month of its initial historical operation.
3. For all scenarios, the MT3D SSM Package was prepared to simulate transport following shutdown of the P&T system during which MNA is the operating remedy. For the potential water table release evaluation, the unit concentrations representing water table impacts at Trenches 31 and 34 were

maintained, whereas for the reinjected water evaluation, the unit concentrations representing reinjected water were not maintained (consistent with system shutdown).

4. Each transport model was executed to simulate the fate of the prescribed unit concentrations over time and produce the required MT3D output files.

5. Post-processing scripts were executed to produce the figures presented in this ECF, including the following:

   a. Plots depicting injected treated water dilution curves at monitoring wells 299-W10-29 and 299-W10-30

   b. Plots depicting unit concentration breakthrough curves at monitoring wells 299-W10-29 and 299-W10-30

   c. Dilution plume maps superimposed with Trench 31/34 release flow pathlines

In the map-based (spatial) figures presented in Chapter 7, the colors of the concentration plume represent the relative concentration in groundwater (versus either the treated water reinjection unit source, or the hypothetical water table release unit source) corresponding with the relative color scale provided in the figure.

7 Results

Appendix A provides simulated groundwater elevations, corresponding to the groundwater table, for each month of CY 2015; Appendix B provides mapped (i.e., interpolated) groundwater elevations, corresponding to the groundwater table, for each month of CY 2015. This chapter presents outputs from the calculations described previously for the scenarios listed in Table 3-2.

7.1 Scenario 1

The dilution curves, release concentration breakthrough curves, and dilution plumes for scenario 1 are presented in the following discussion.

7.1.1 Dilution Curves

Figures 7-1 and 7-2 depict the simulated breakthrough at wells 299-W10-30 and 299-W10-29, respectively, of a unit concentration representing treated water reinjected at injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226. The release time corresponds to the CY 2012 startup of the 200 West P&T.

7.1.2 Release Concentration Breakthrough Curves

Figures 7-3 and 7-4 depict the simulated breakthrough of a unit-source water table release from Trenches 31 and 34, at monitoring wells 299-W10-30 and 299-W10-29, respectively. The release time corresponds to October 1, 2015.

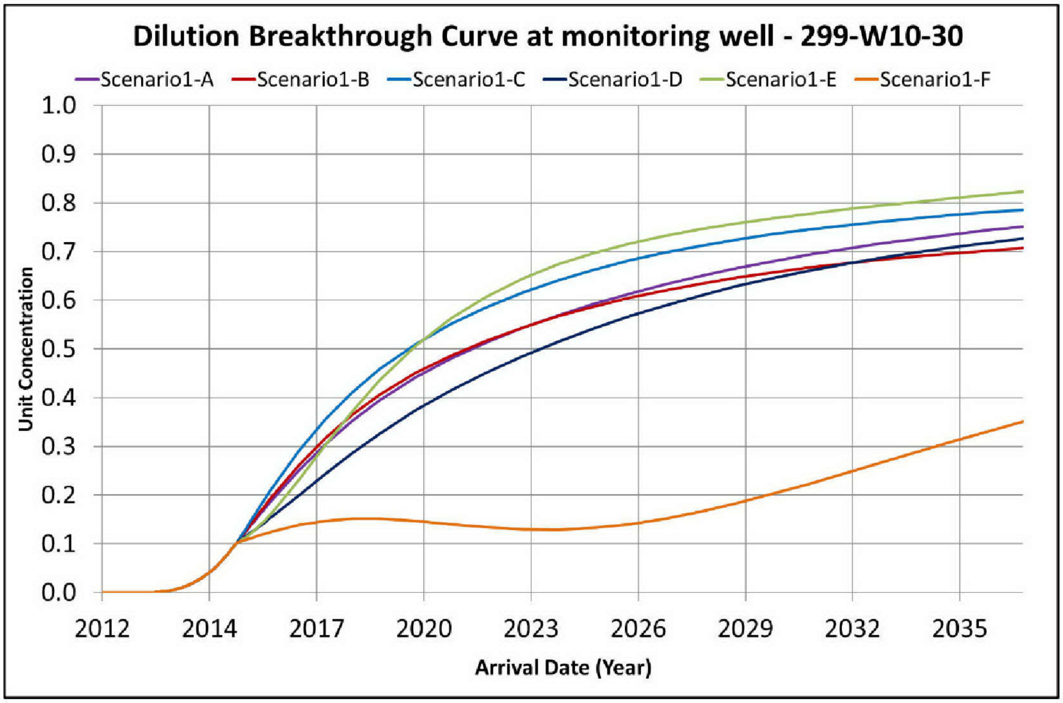

Figure 7-1. Injected Treated Water Dilution Curves at Monitoring Well 299-W10-30

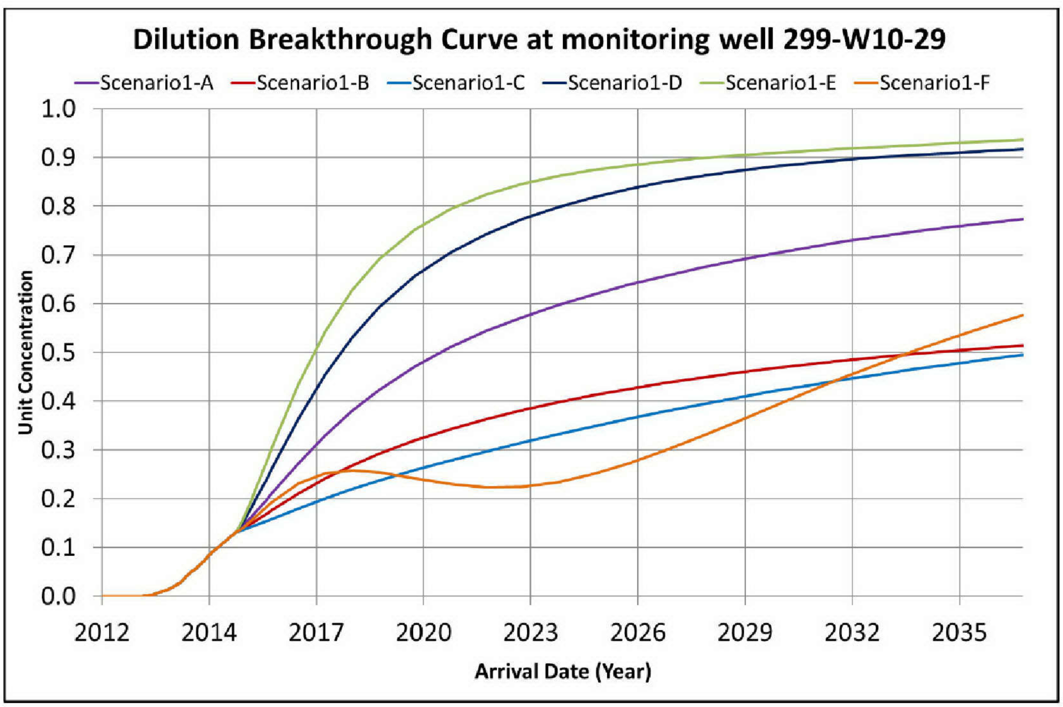

Figure 7-2. Injected Treated Water Dilution Curves at Monitoring Well 299-W10-29

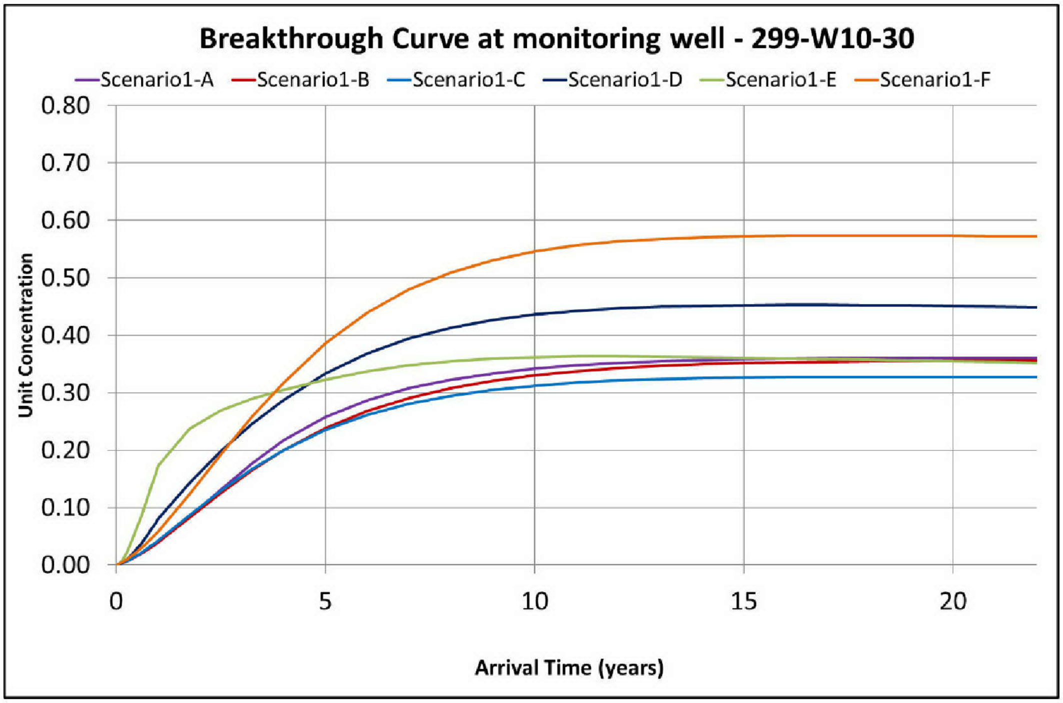

Figure 7-3. Release Concentration Curves at Monitoring Well 299-W10-30

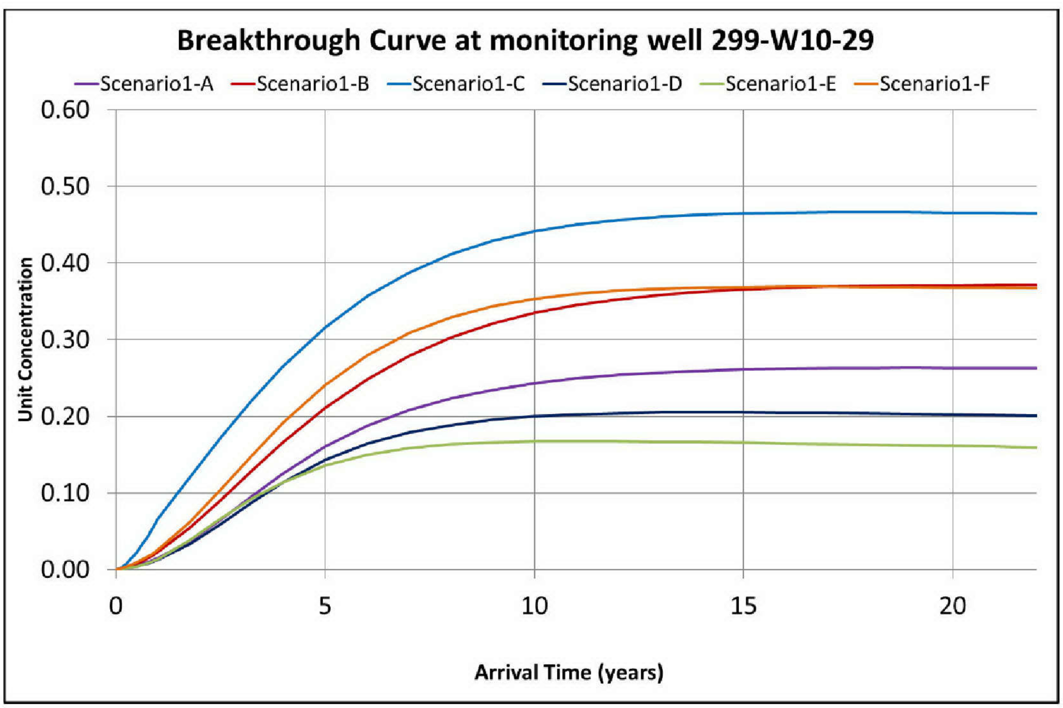

Figure 7-4. Release Concentration Curves at Monitoring Well 299-W10-29

7.1.3 Dilution Plumes

Figure 7-5 depicts the simulated path of treated water that is reinjected at injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226 when considering advection only for scenario 1-A. Figure 7-6 depicts the same simulated paths overlain on the dilution plume simulated assuming unit sources at 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226. These figures illustrate the correspondence between the MODPATH particle-tracking and MT3D transport simulations, as a precursor to presenting depictions of the dilution plumes and advective-dispersive pathlines in subsequent figures.

Figure 7-5. Scenario 1-A Injection Well Release Flow Pathlines (Advection Only)

Figure 7-6. Scenario 1-A Dilution Plume Superimposed with Injection Well Release Flow Pathlines (Advection Only)

Figures 7-7 through 7-12 depict simulated dilution plumes. The colored regions in the figures represent the relative fraction of reinjected water that is introduced at injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226, as well as the simulated migration pathway for a hypothetical water table release below Trenches 31 and 34 when considering advection and dispersion for scenarios 1-A through 1-F, respectively (see Table 3-2 for scenario details).

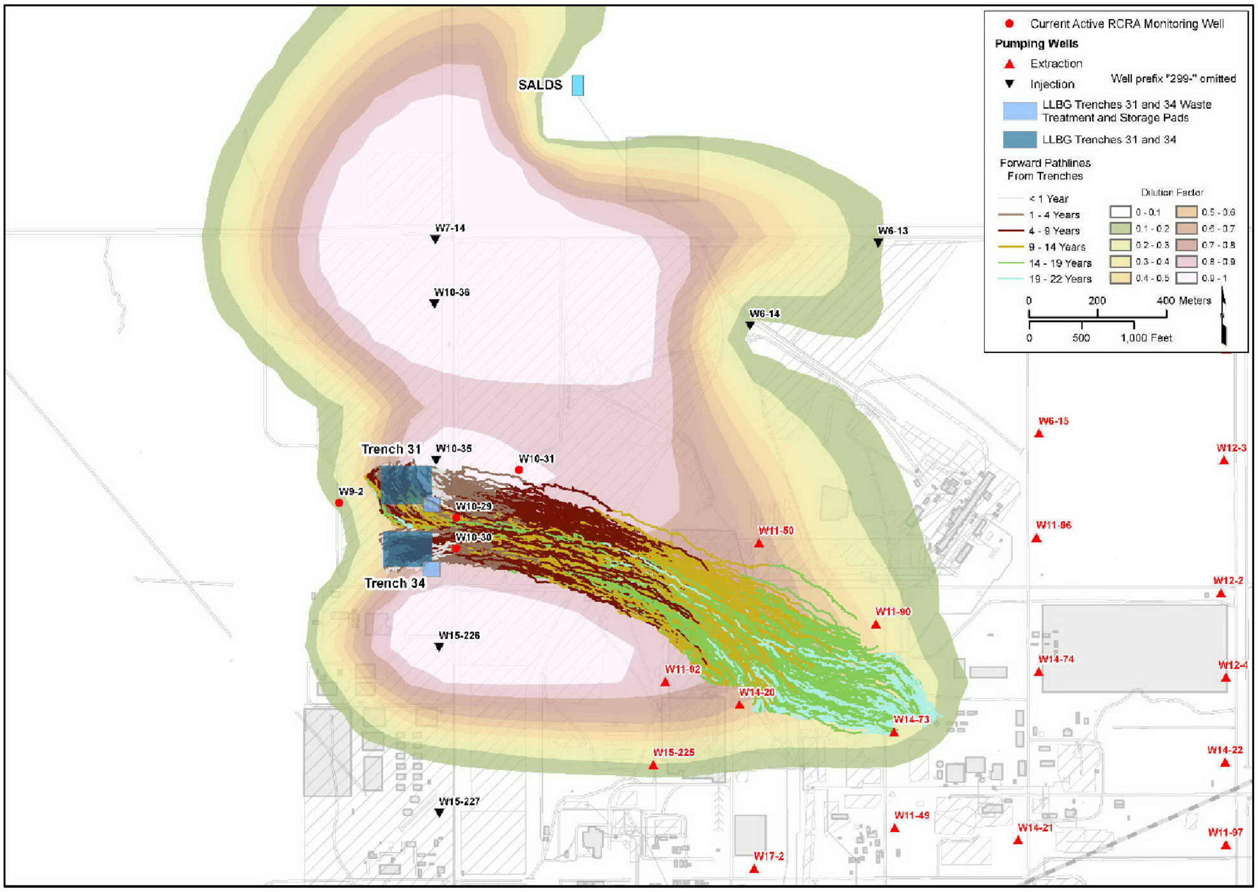

Figure 7-7. Scenario 1-A Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

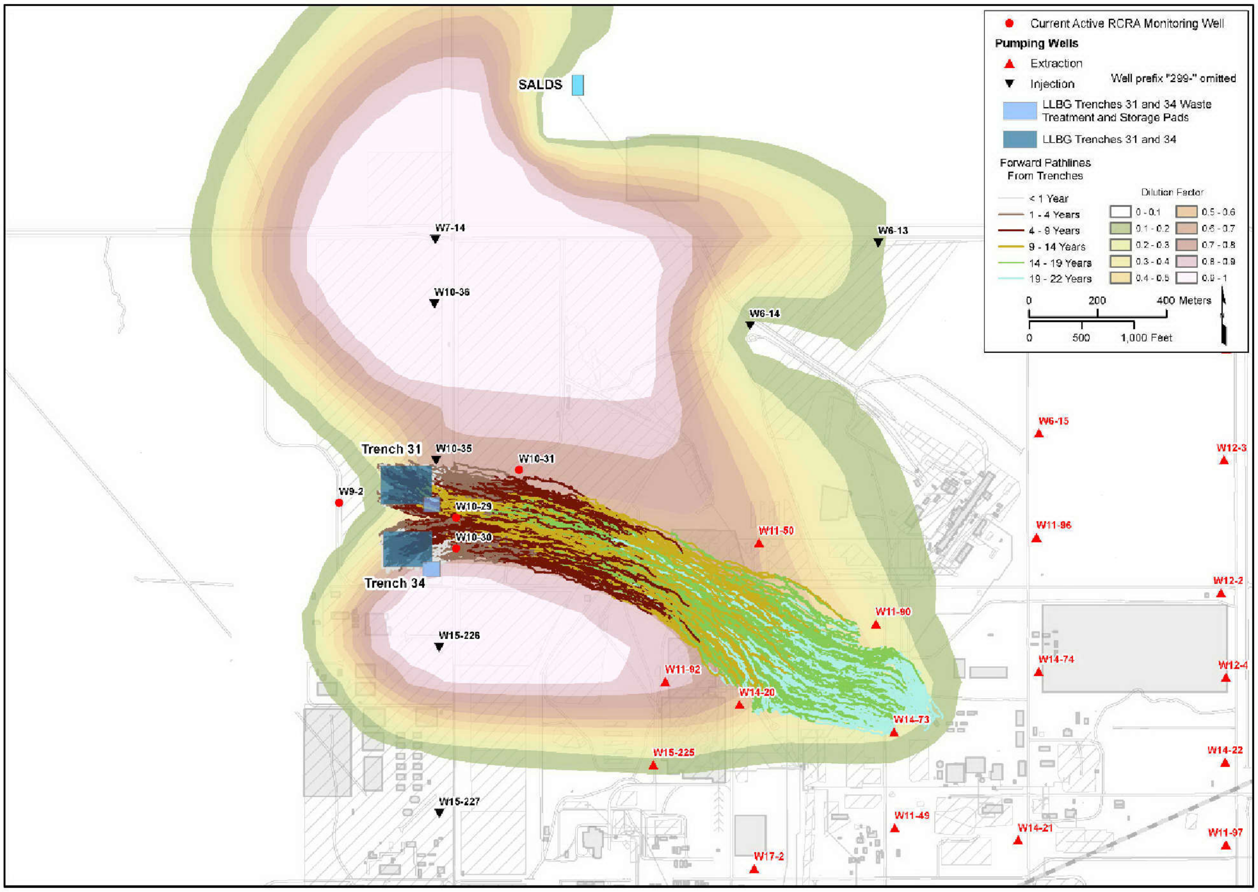

Figure 7-8. Scenario 1-B Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

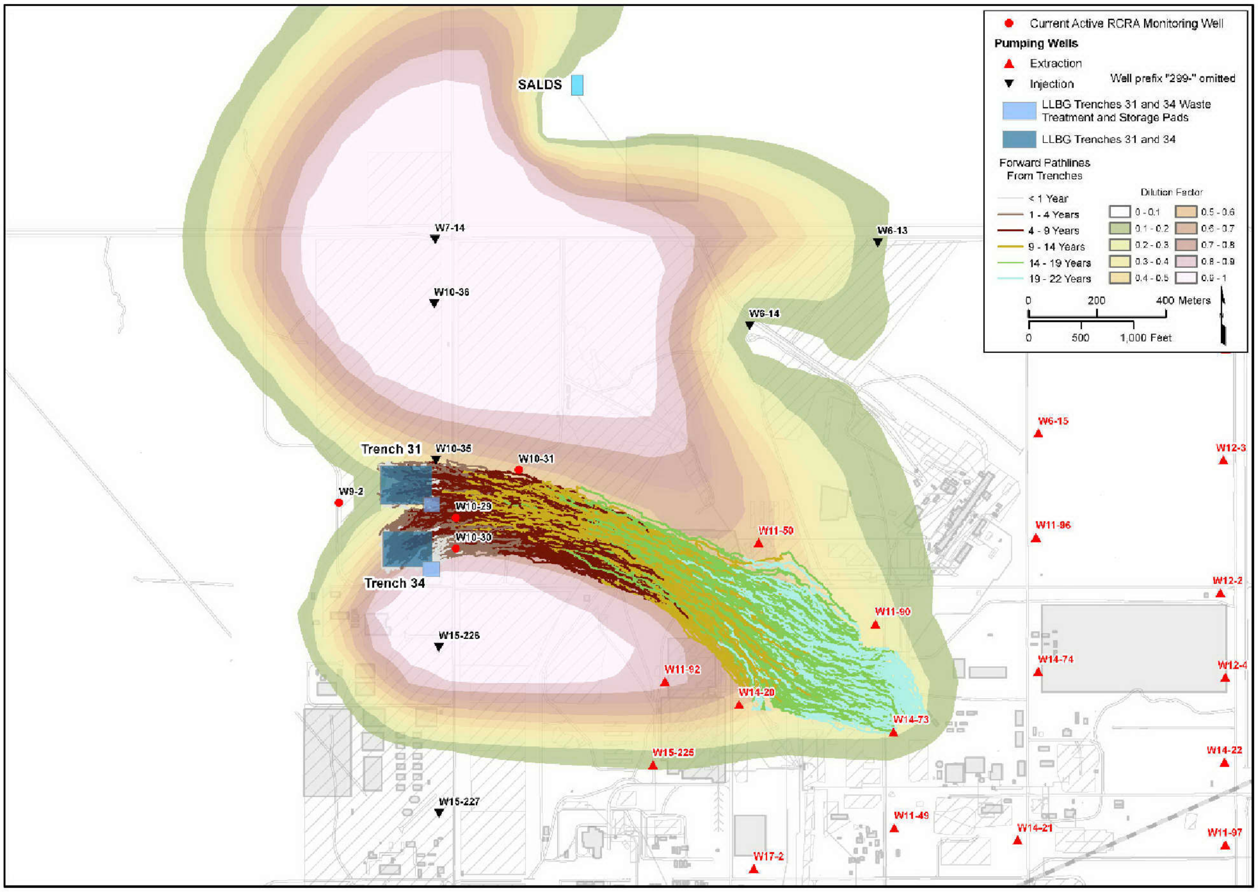

Figure 7-9. Scenario 1-C Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

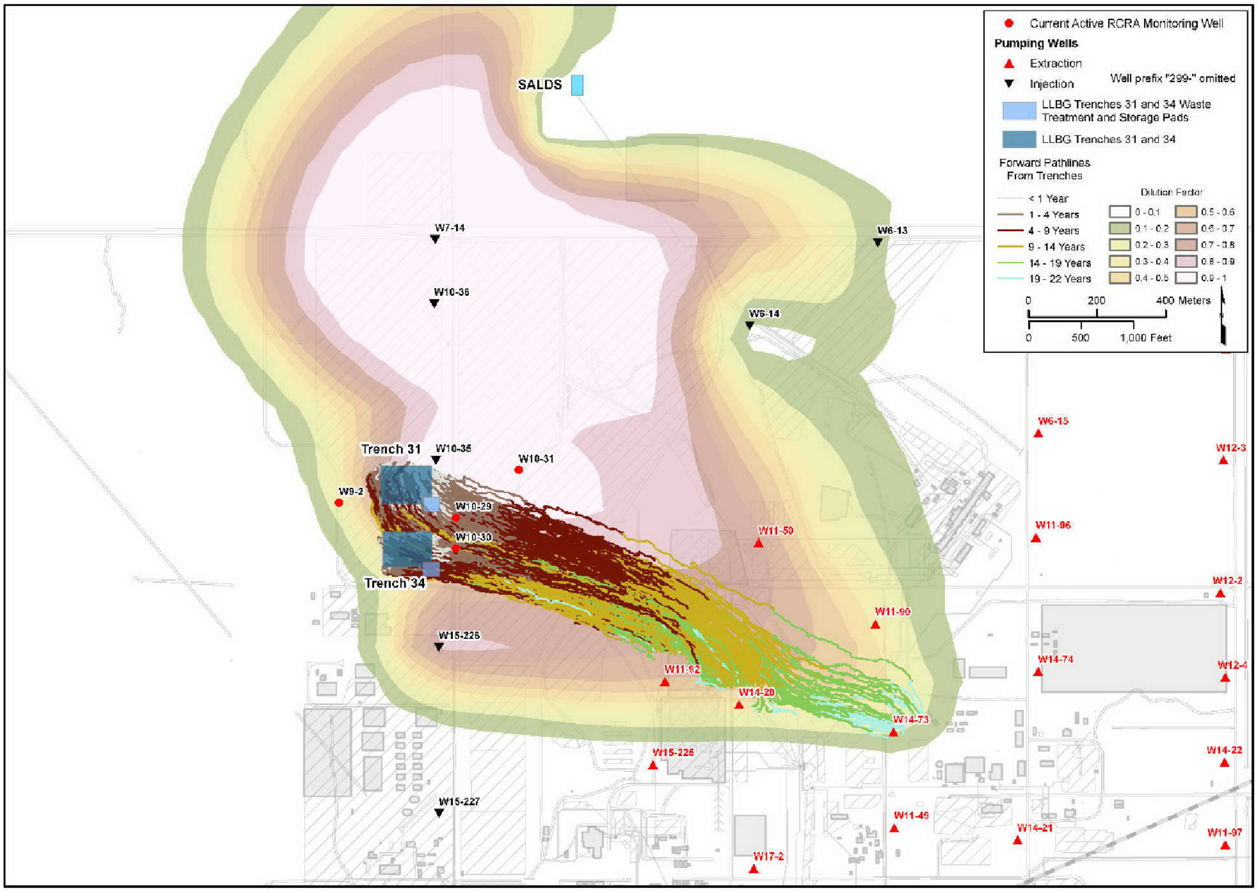

Figure 7-10. Scenario 1-D Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

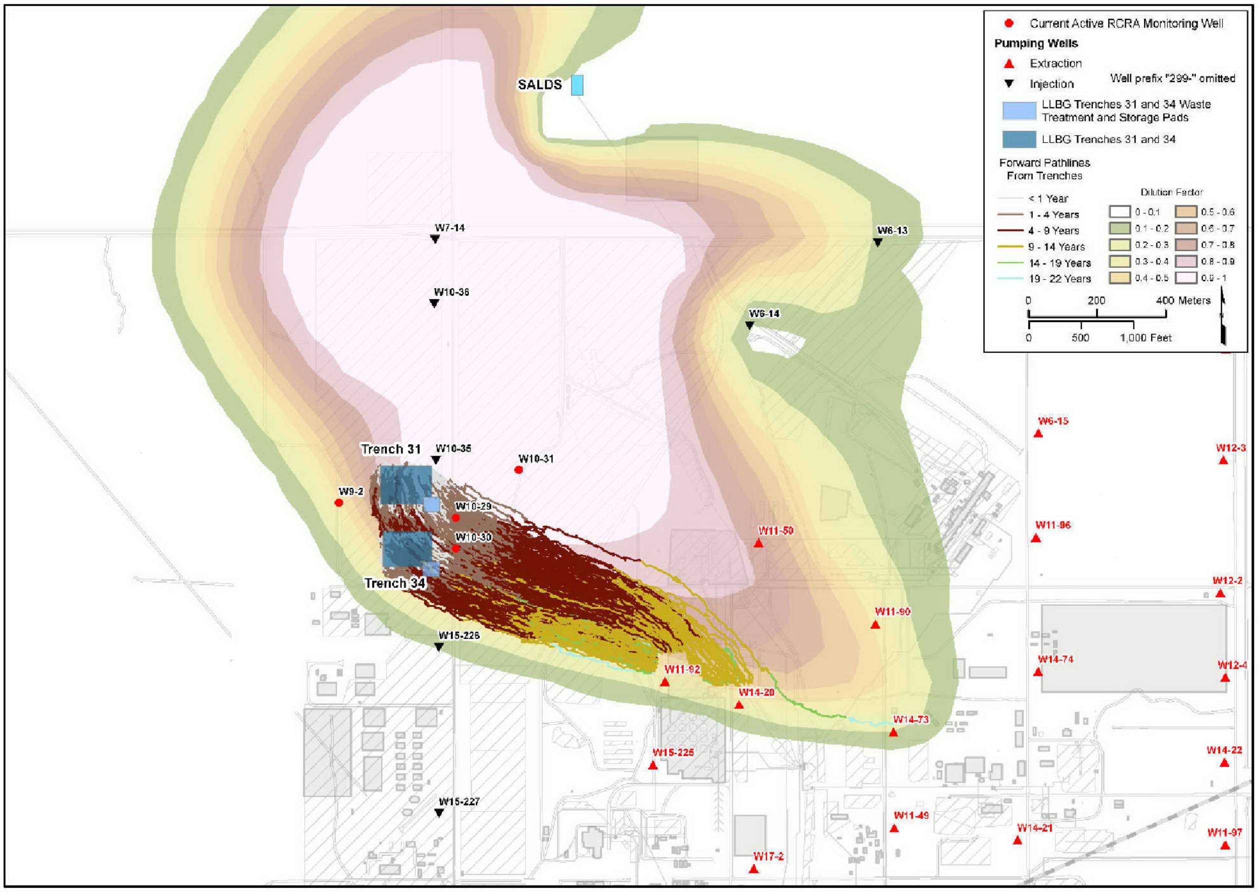

Figure 7-11. Scenario 1-E Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

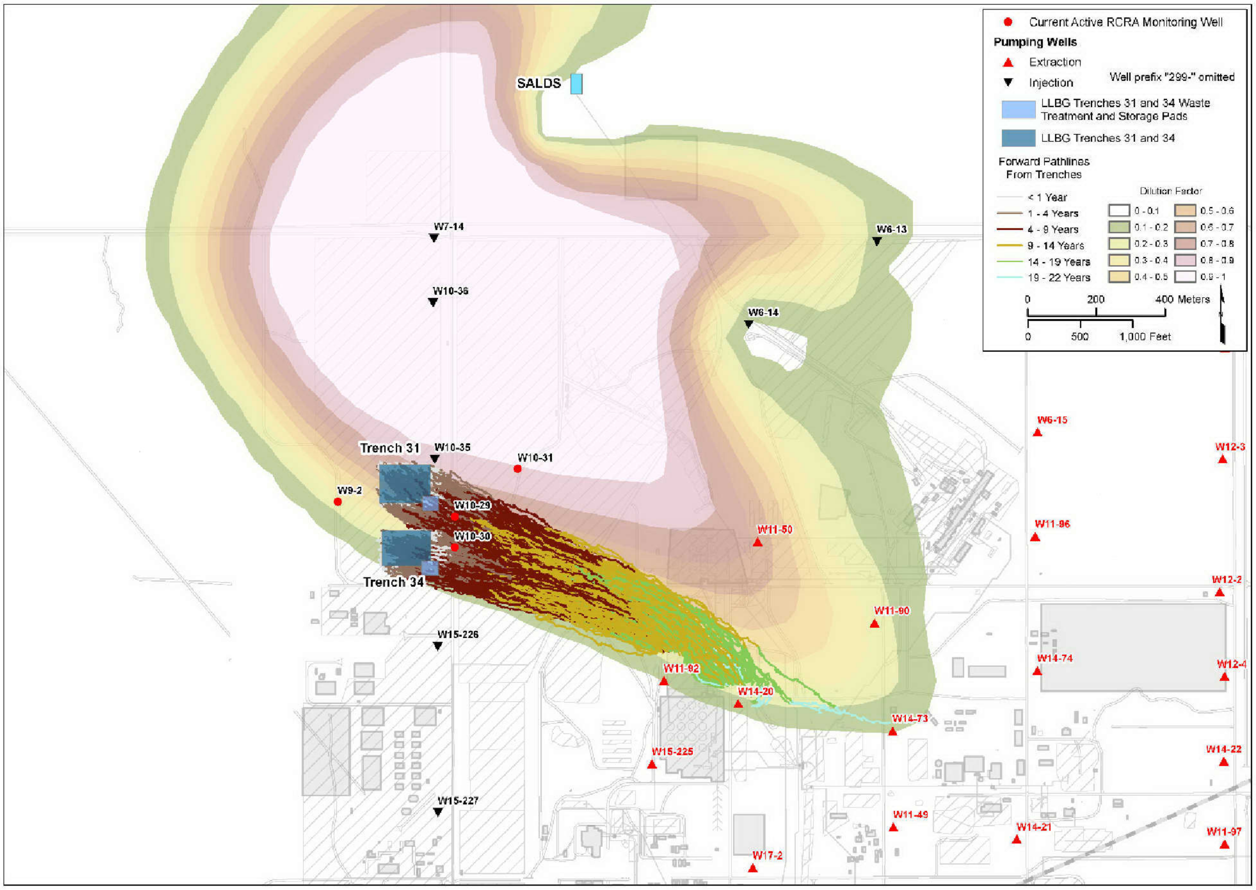

Figure 7-12. Scenario 1-F Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

Appendix C presents maps of the count of particles that traversed each cell of the refined calculation subgrid for each subscenario of scenario 1, when particle tracking is simulated using advection and dispersion. Figure 7-13 depicts the relative detectability as calculated for scenario 1 on the 20 m by 20 m calculation subgrid.

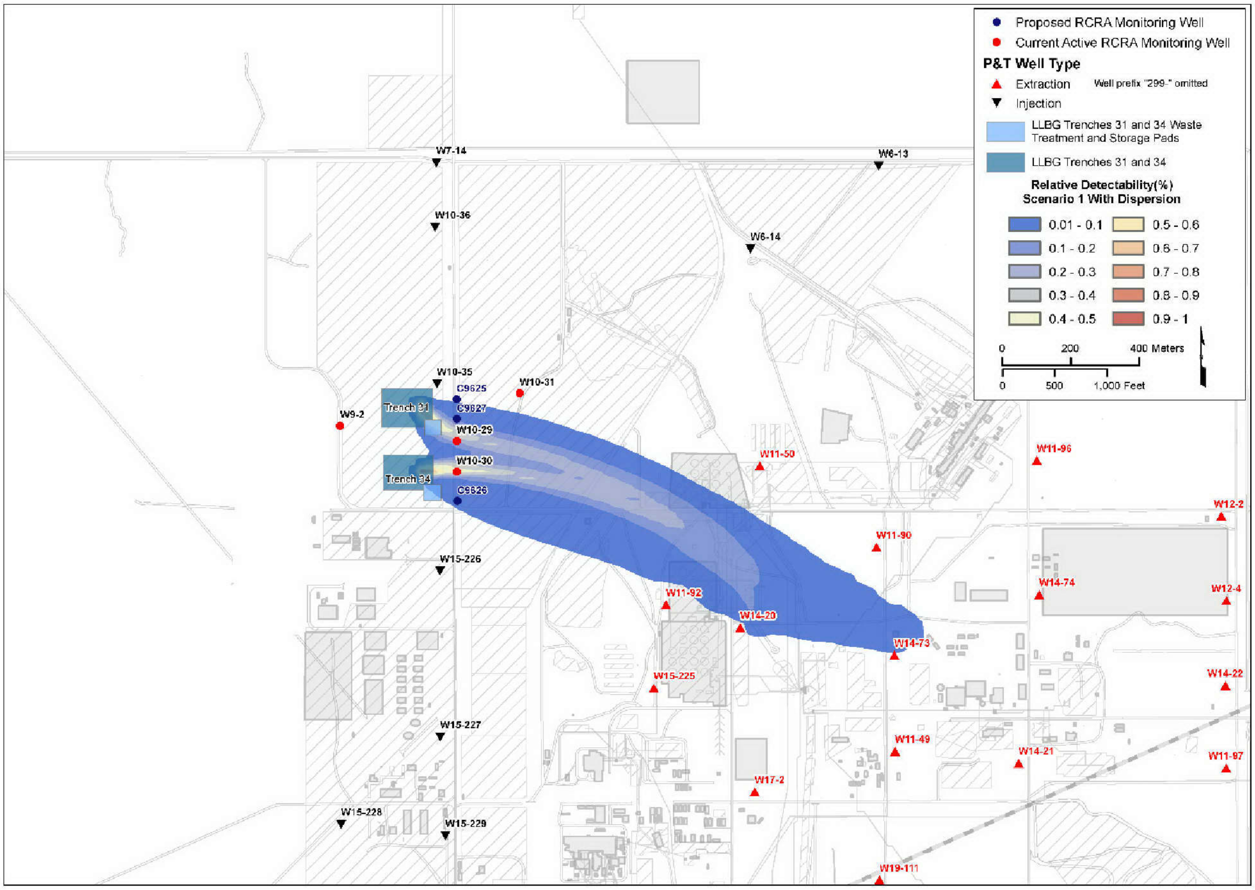

Figure 7-13. Map of Relative Detectability – Scenario 1

7.2 Scenario 2

The dilution curves, release concentration breakthrough curves, and dilution plumes for scenario 2 are presented in the following discussion.

7.2.1 Dilution Curves

Figures 7-14 and 7-15 depict the simulated breakthrough at wells 299-W10-30 and 299-W10-29, respectively, of a unit concentration representing treated water reinjected at injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226. The release time corresponds to the CY 2012 startup of the 200 West P&T.

7.2.2 Release Dilution Breakthrough Curves

Figures 7-16 and 7-17 depict the simulated breakthrough of a unit-source water table release from Trenches 31 and 34 at monitoring wells 299-W10-30 and 299-W10-29, respectively. The release time corresponds to October 1, 2015.

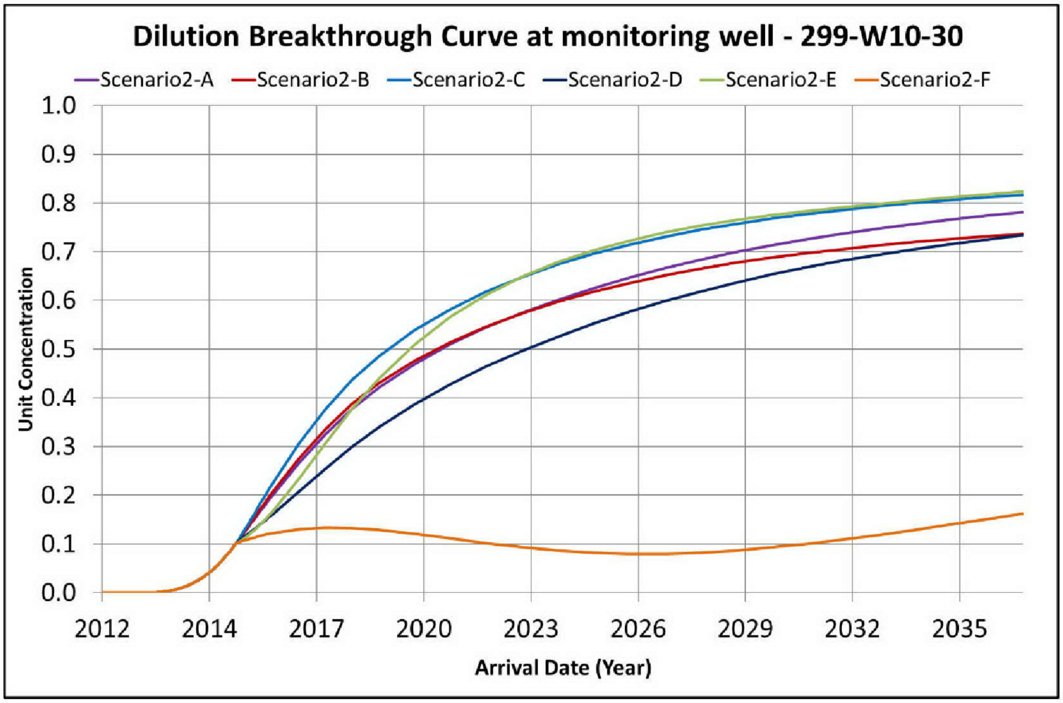

Figure 7-14. Injected Treated Water Dilution Curves at Monitoring Well 299-W10-30

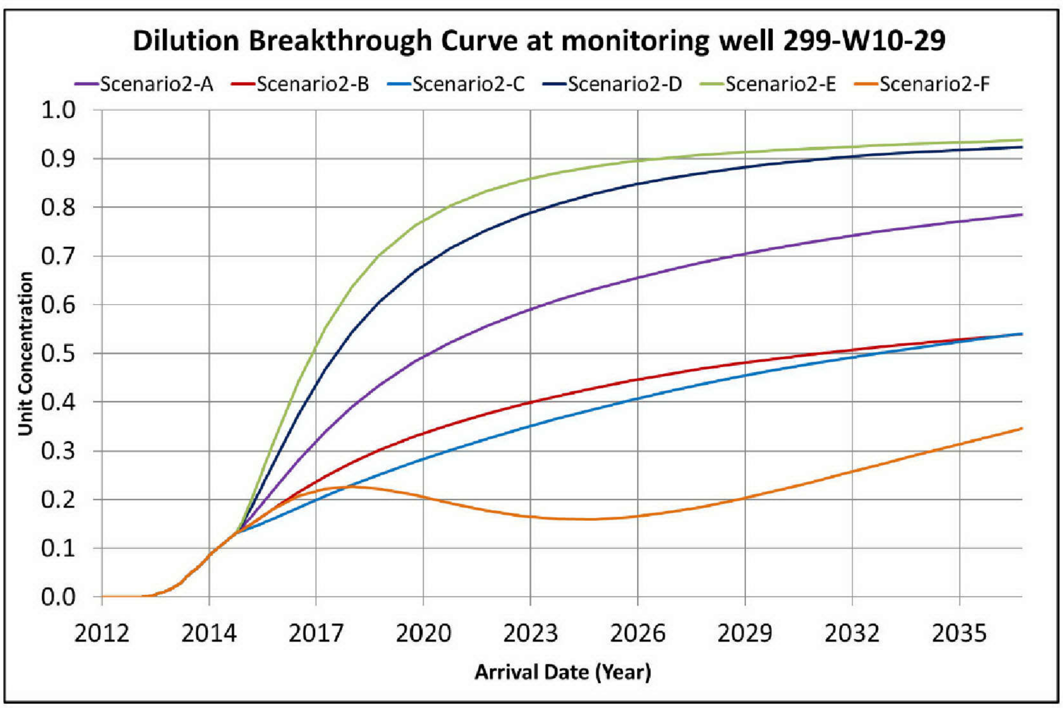

Figure 7-15. Injected Treated Water Dilution Curves at Monitoring Well 299-W10-29

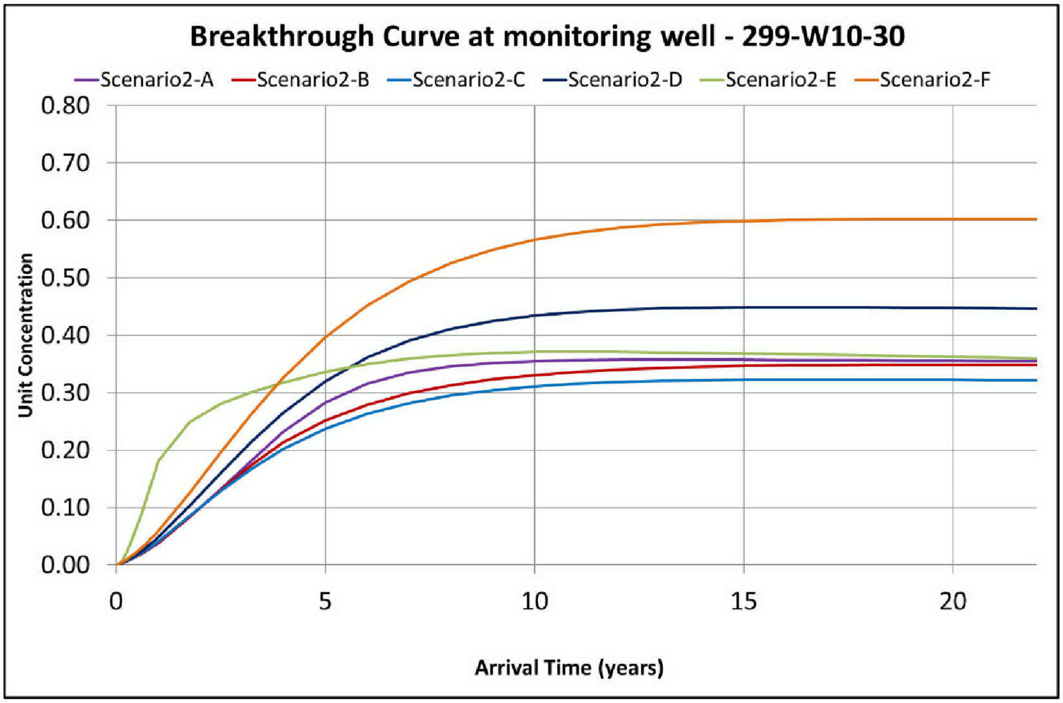

Figure 7-16. Release Concentration Curves at Monitoring Well 299-W10-30

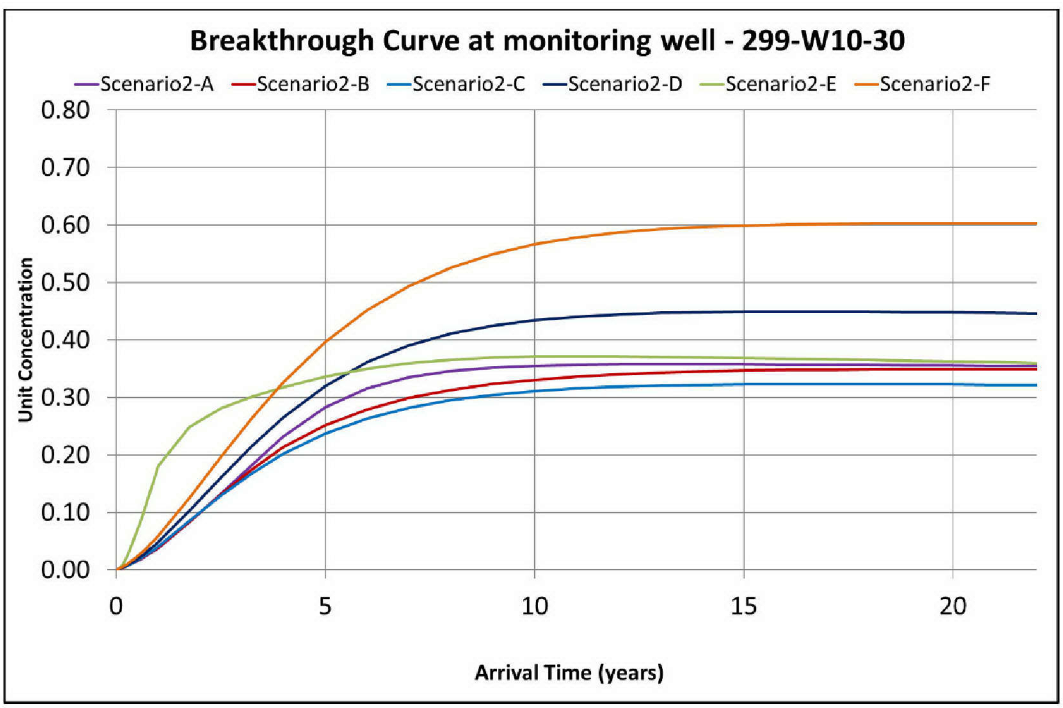

Figure 7-17. Release Concentration Curves at Monitoring Well 299-W10-29

7.2.3 Dilution Plumes

Figures 7-18 through 7-23 depict simulated dilution plumes. The colored regions in the figures represent the relative fraction of reinjected water that is introduced at injection wells 299-W7-14, 299-W10-36, 299-W10-35, and 299-W15-226, as well as simulated migration pathway for a hypothetical water table release below Trenches 31 and 34 when considering advection and dispersion for scenarios 2-A through 2-F, respectively (see Table 3-2 for scenario details).

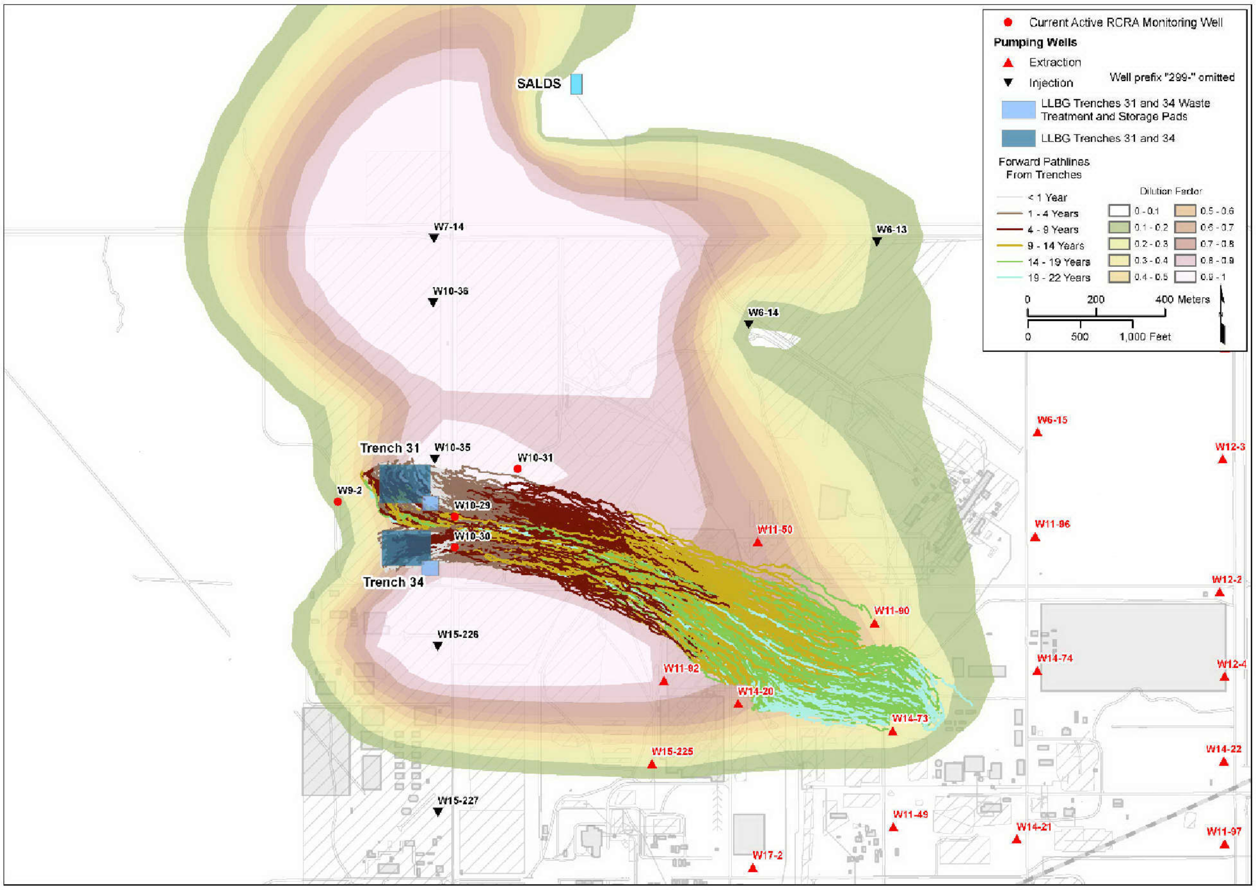

Figure 7-18. Scenario 2-A Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

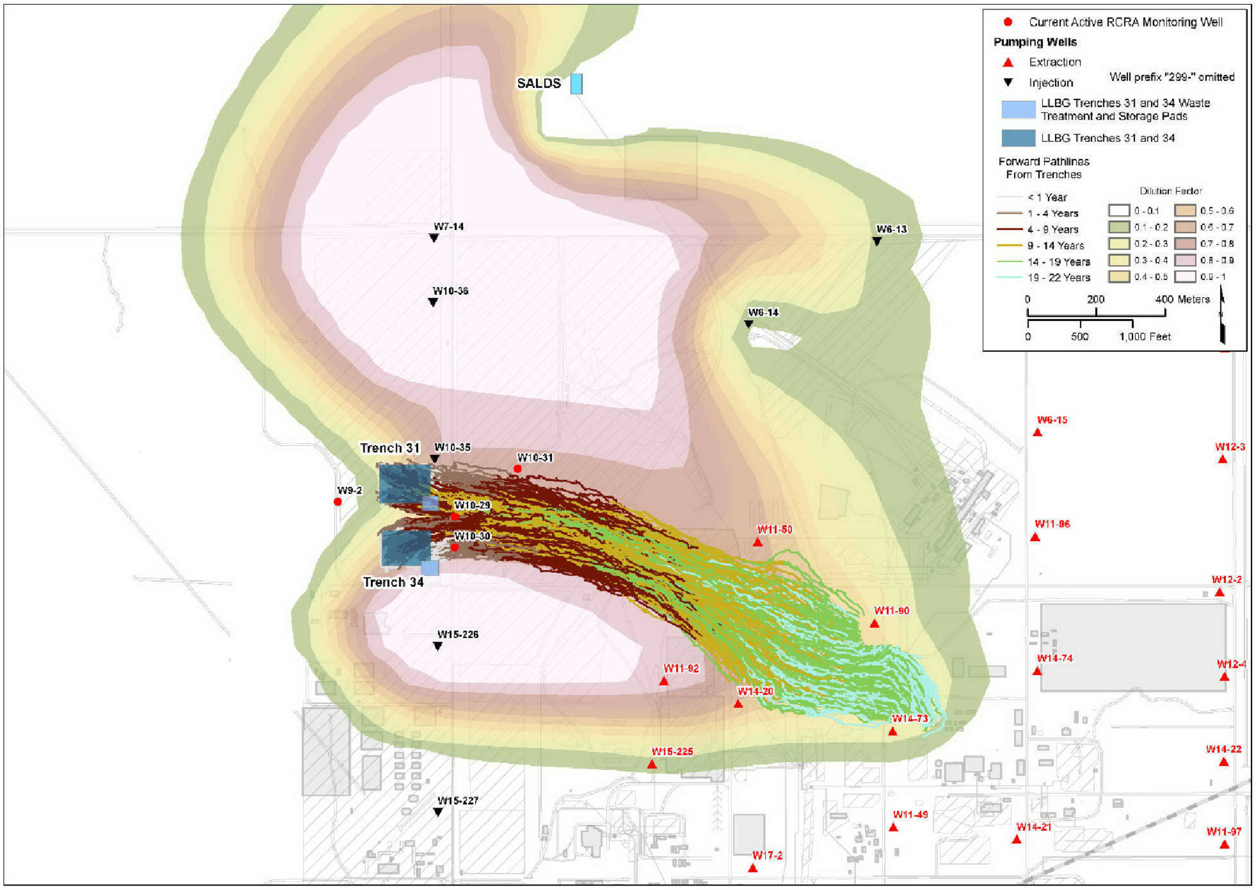

Figure 7-19. Scenario 2-B Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

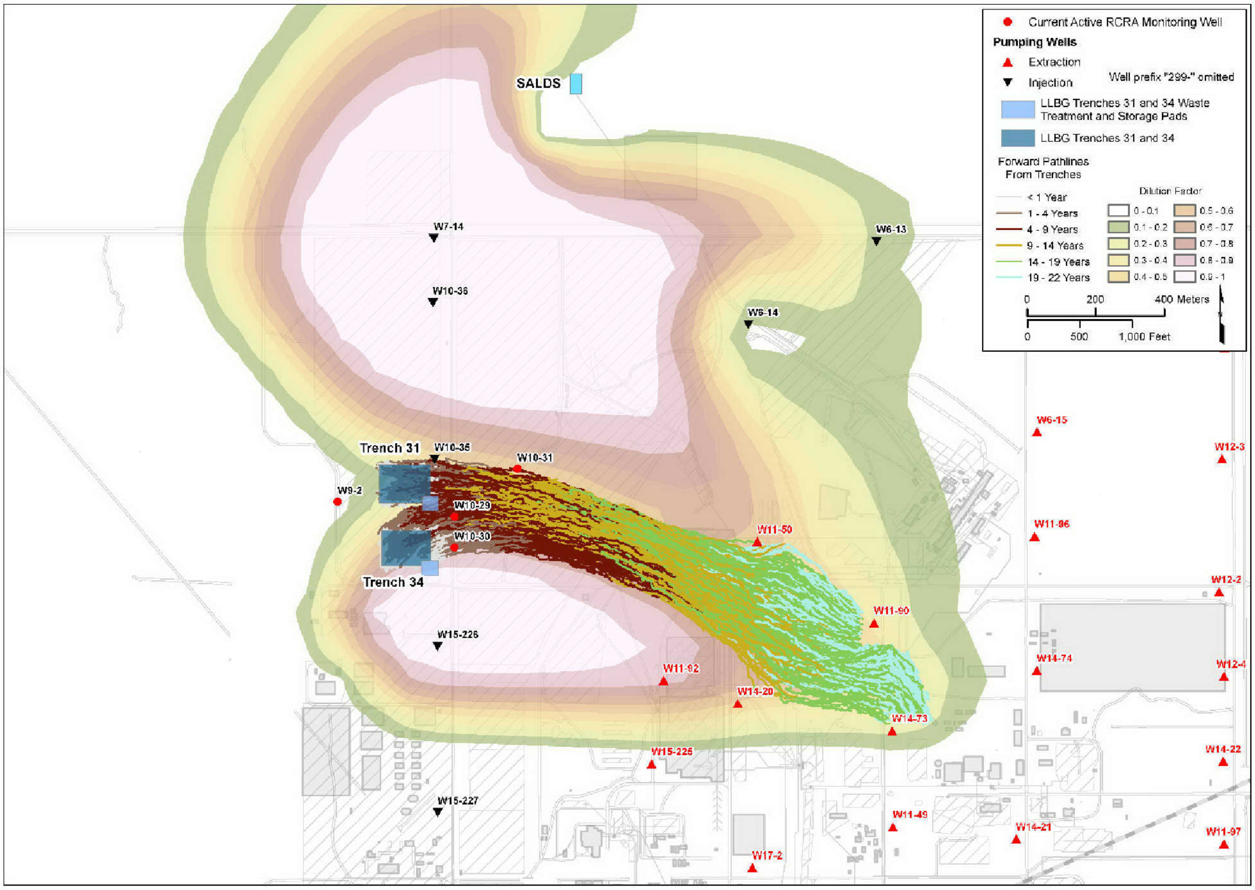

Figure 7-20. Scenario 2-C Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

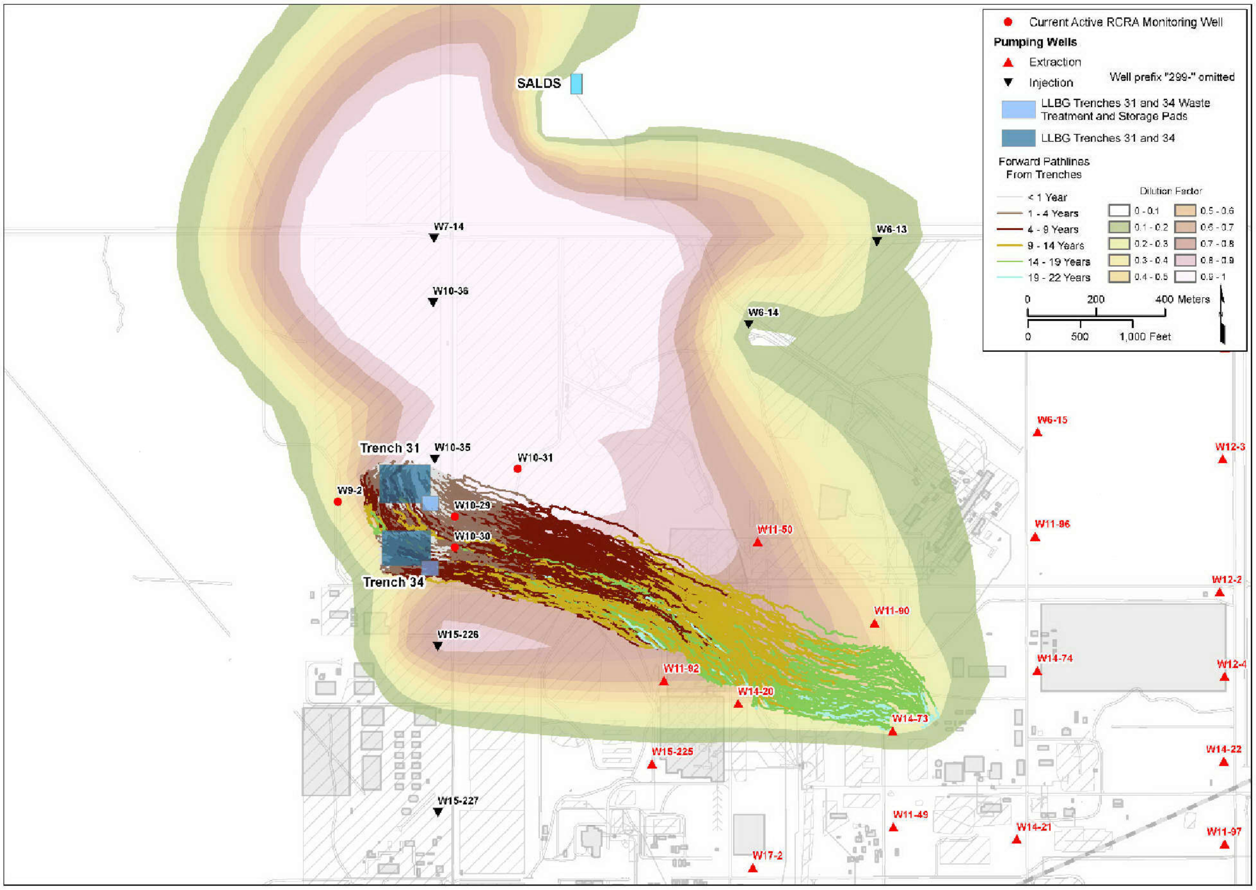

Figure 7-21. Scenario 2-D Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

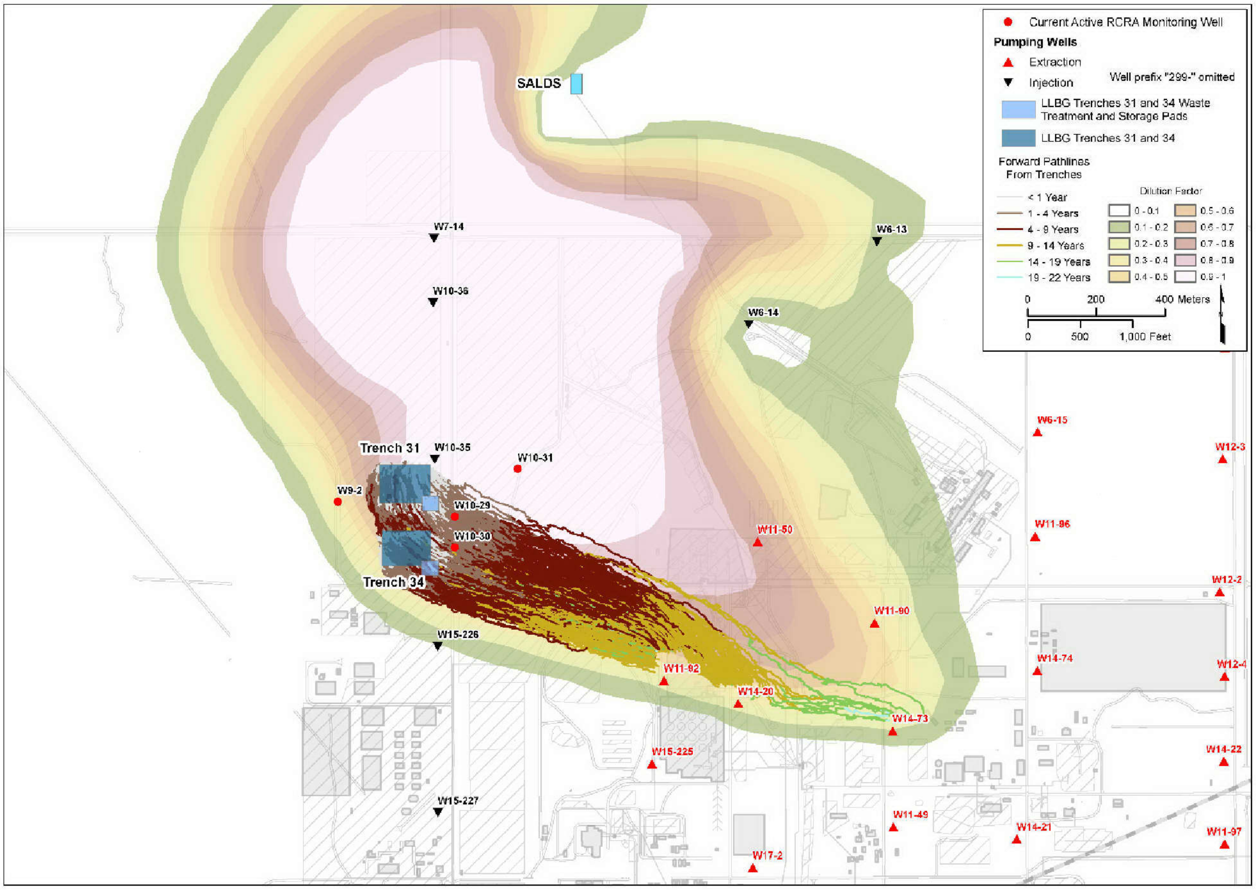

Figure 7-22. Scenario 2-E Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

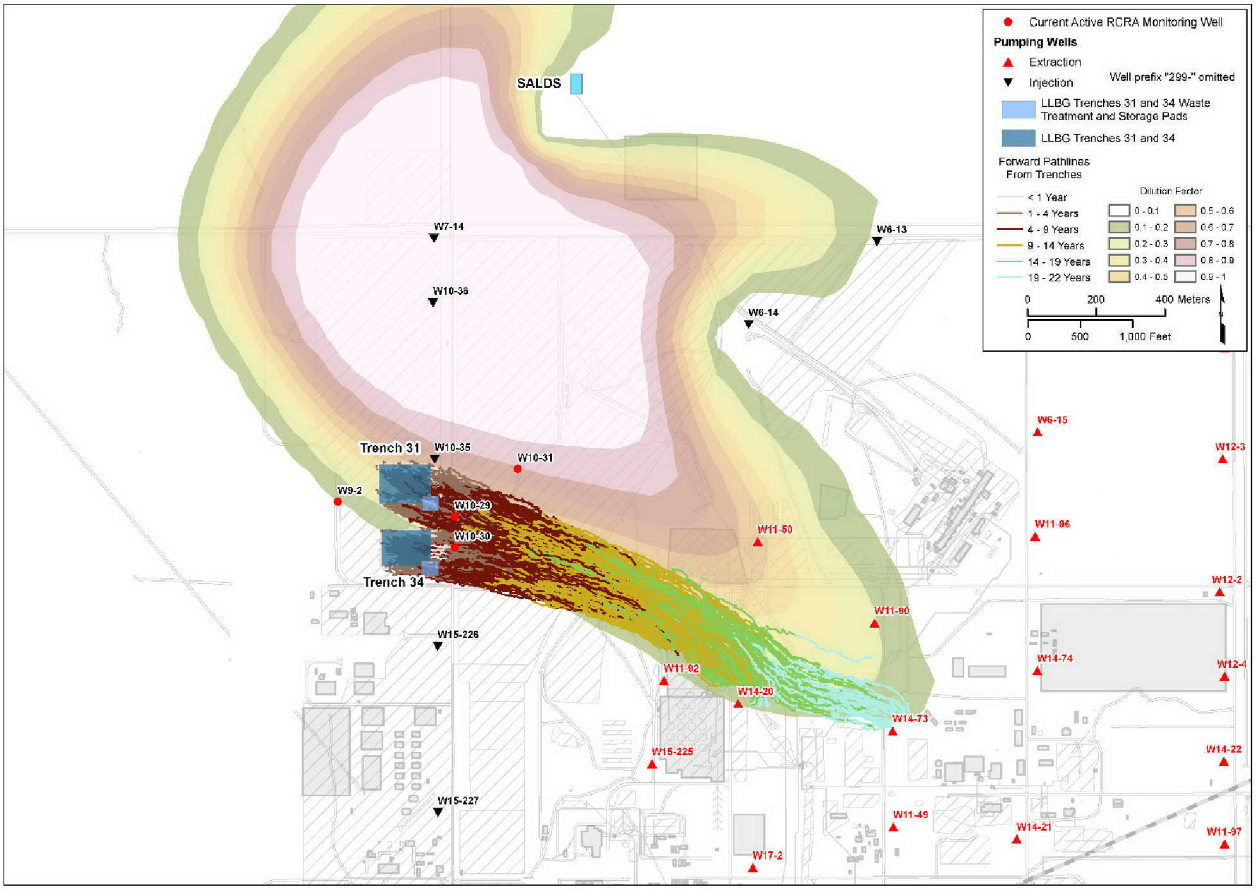

Figure 7-23. Scenario 2-F Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

Appendix C presents maps of the count of particles that traversed each cell of the refined calculation subgrid for each subscenario of scenario 2, when particle tracking is simulated using advection and dispersion. Figure 7-24 depicts the relative detectability as calculated for scenario 2 on the 20 m by 20 m calculation subgrid.

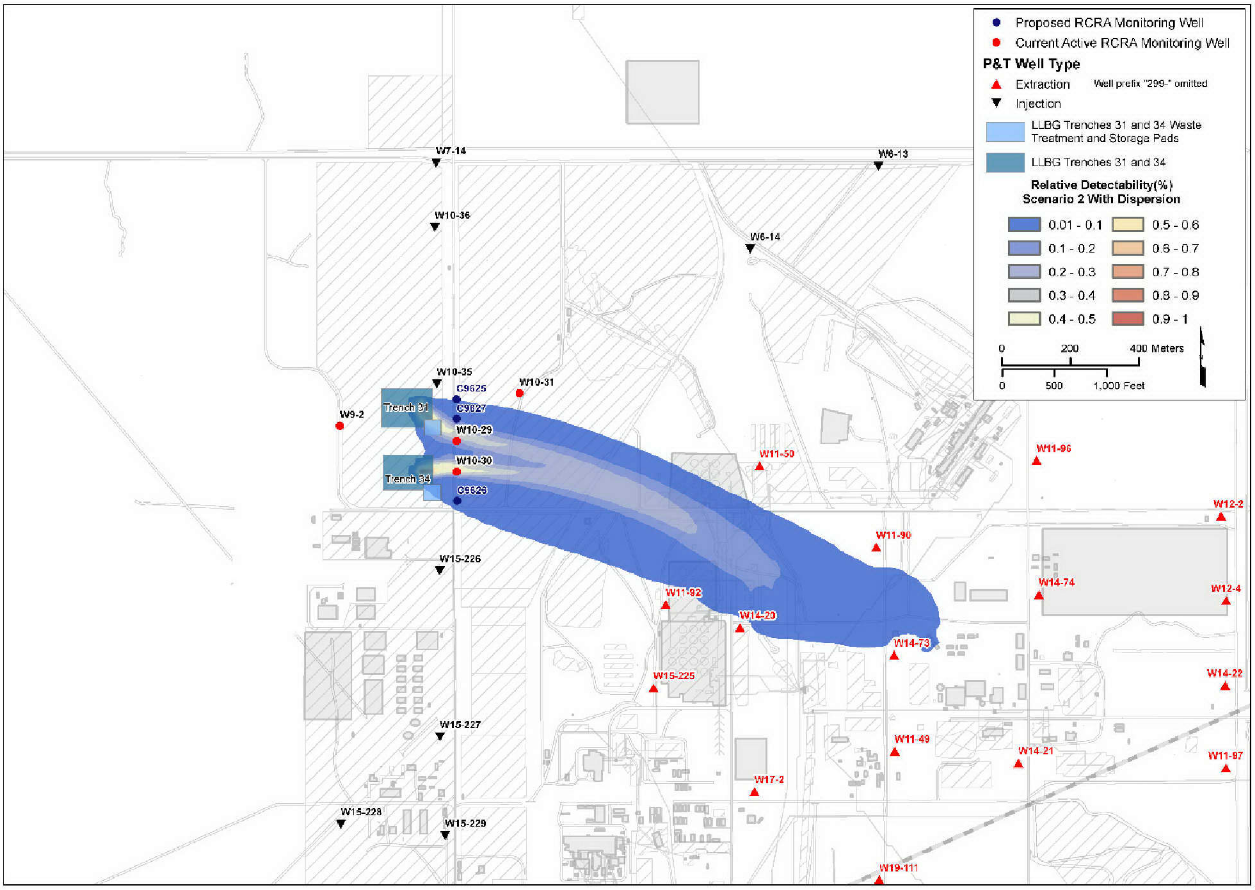

Figure 7-24. Map of Relative Detectability – Scenario 2

7.3 Scenario 3

Figure 7-25 depicts the simulated breakthrough of a unit-source water table release from Trenches 31 and 34 at monitoring wells 299-W10-30 and 299-W10-29, respectively. The release time corresponds to October 1, 2037.

Figure 7-26 depicts the simulated concentration plume corresponding to a unit-source water table release from Trenches 31 and 34 that occurs immediately following cessation of the operation of the 200 West P&T (i.e., following shutdown in 2037 [scenario 3]). The simulated migration pathway is also shown for the same hypothetical water table release below Trenches 31 and 34 when considering advection and dispersion (see Table 3-2 for scenario details).

Appendix C presents maps of the count of particles that traversed each cell of the refined calculation subgrid for scenario 3, when particle tracking is simulated using advection and dispersion. Figure 7-27 depicts the relative detectability as calculated for scenario 3 on the 20 m by 20 m calculation subgrid.

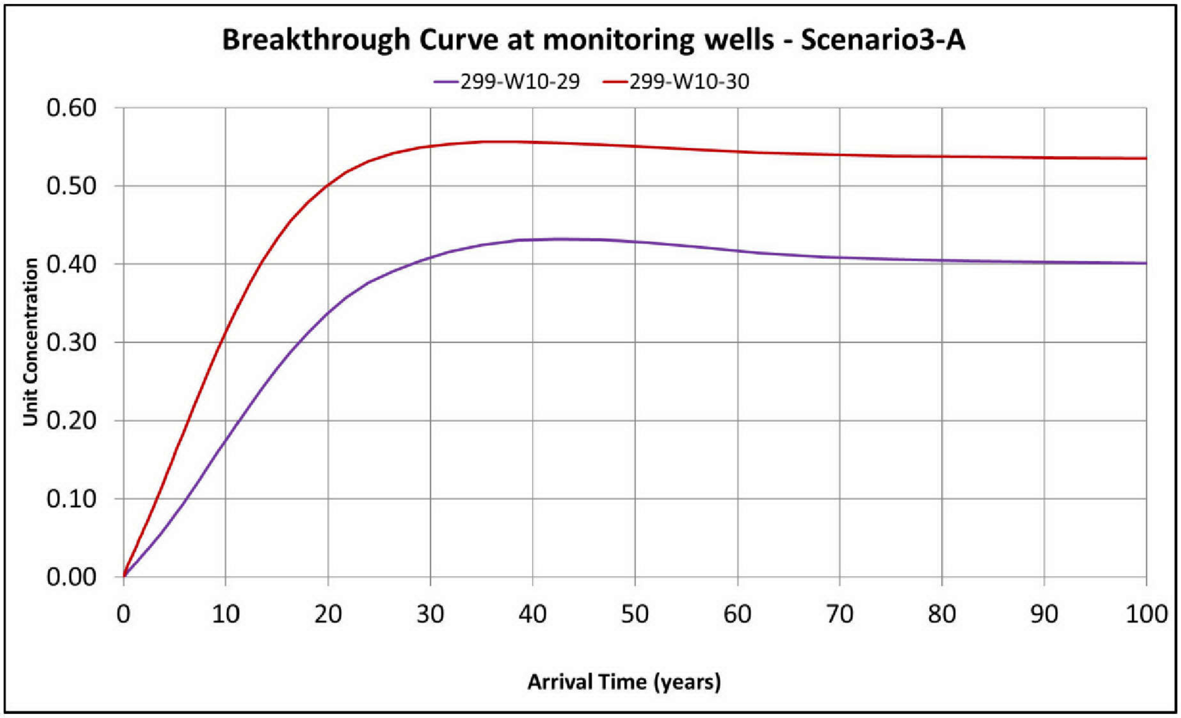

Figure 7-25. Release Concentration Curves at Monitoring Wells Scenario 3

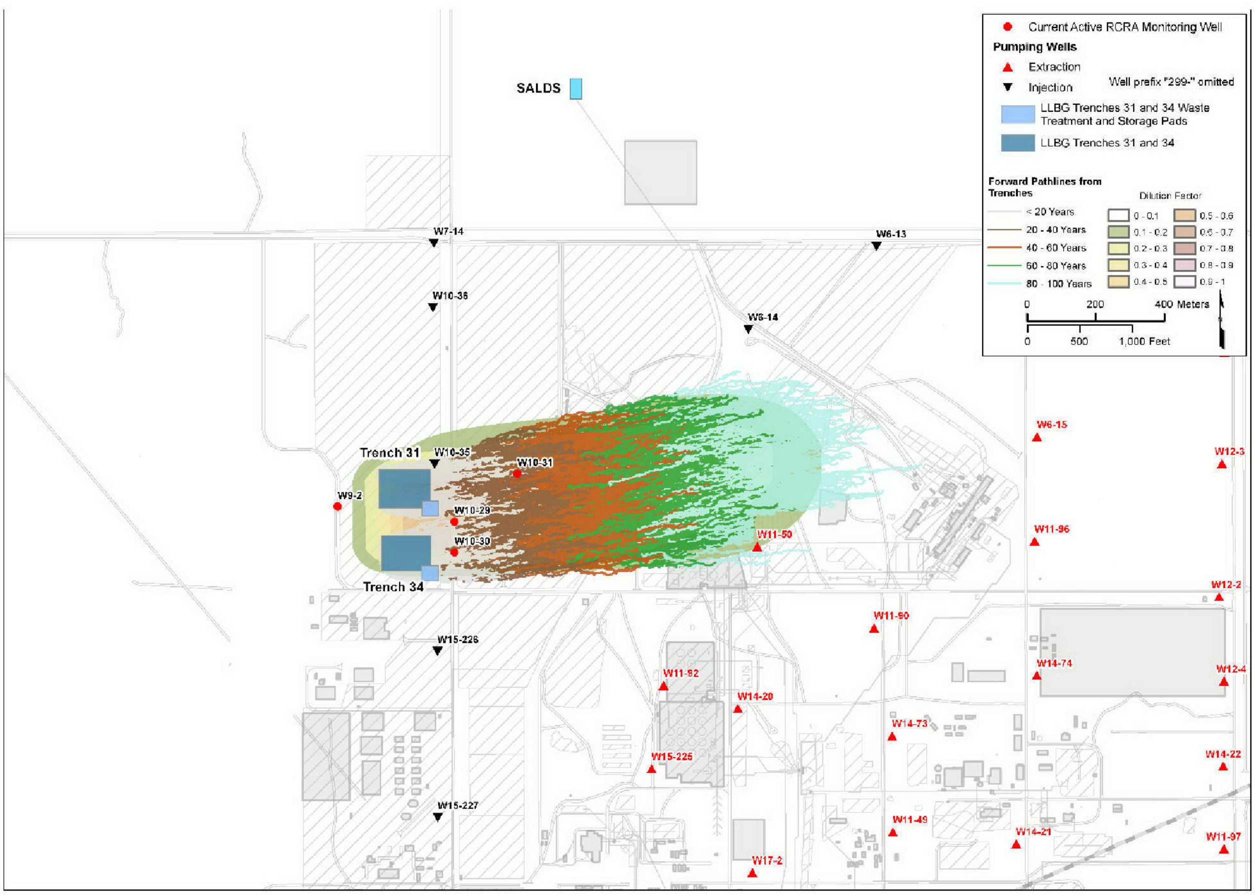

Figure 7-26. Scenario 3 Dilution Plume Superimposed with Trench 31/34 Release Flow Pathlines

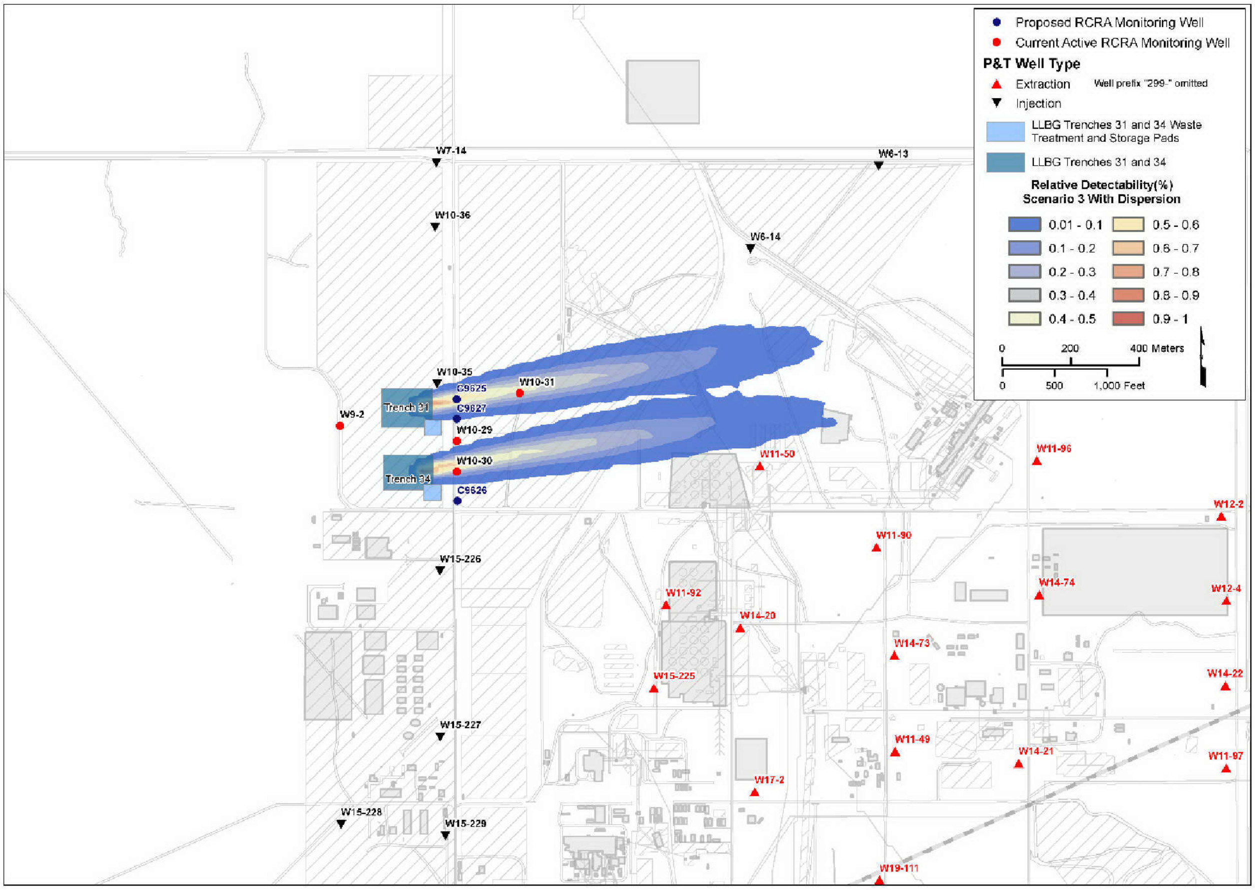

Figure 7-27. Map of Relative Detectability – Scenario 3

8 References

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Appendix A

Simulated Water Level Maps

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Figures

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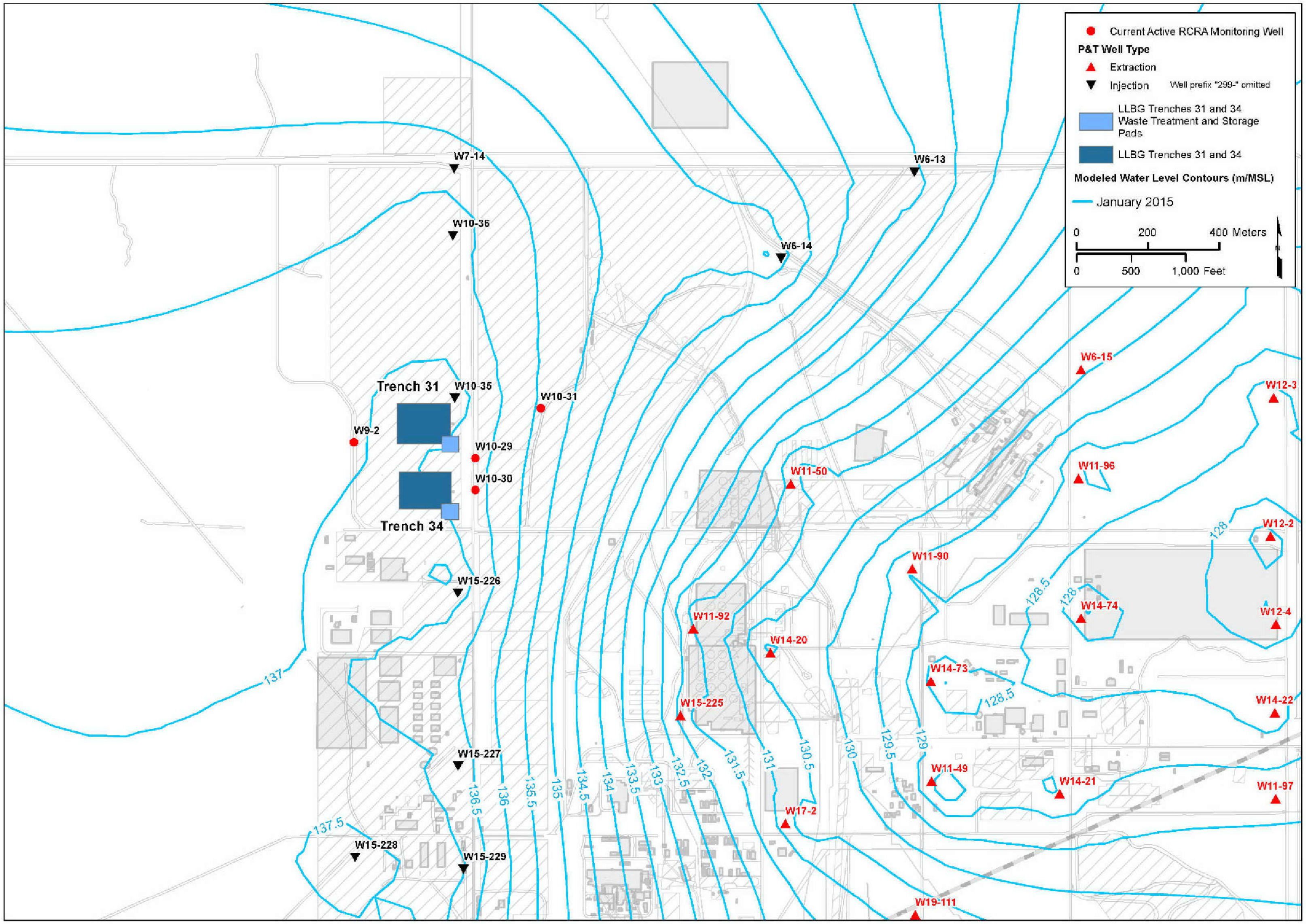

Figure A-1. Simulated Water Levels in January 2015

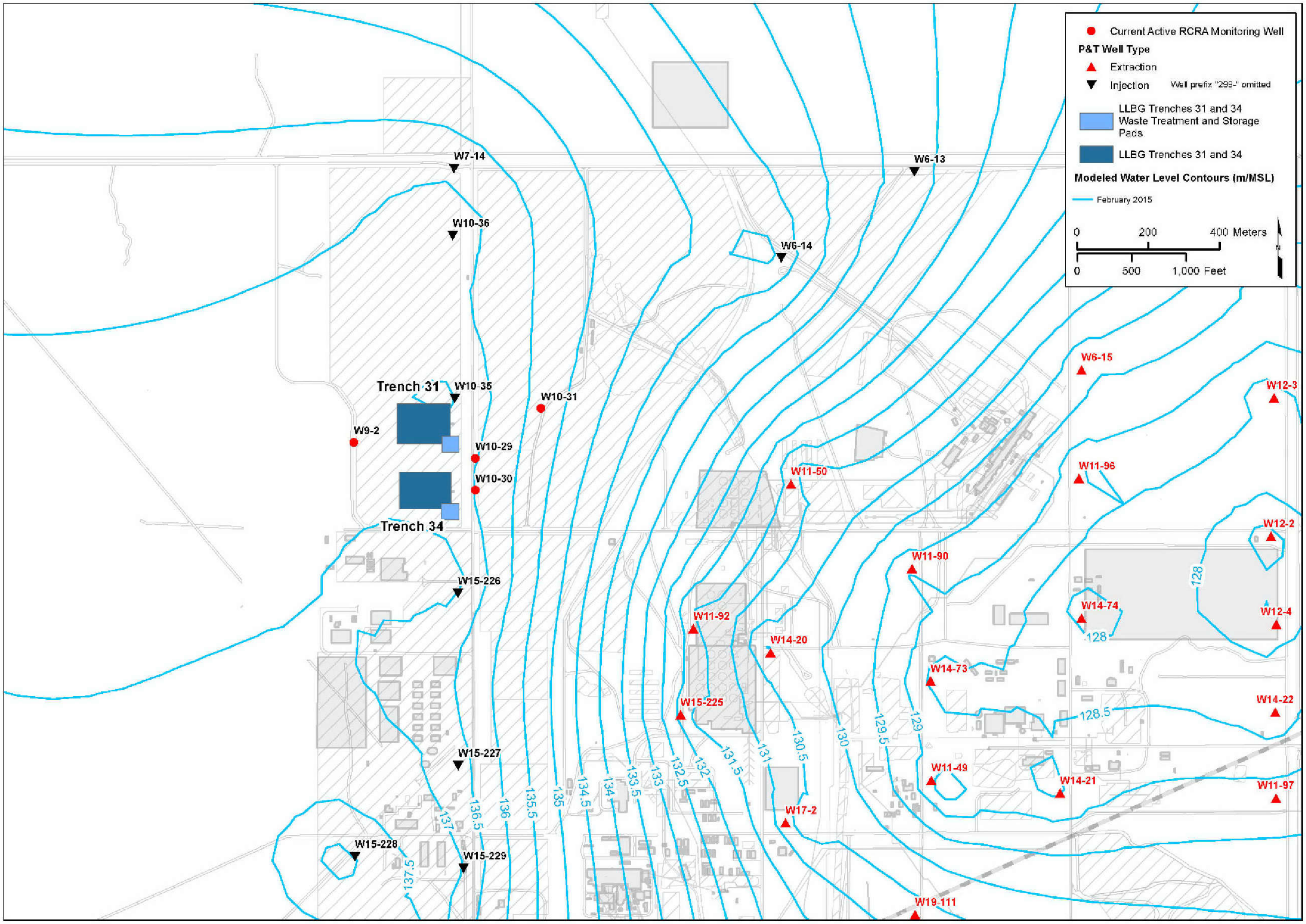

Figure A-2. Simulated Water Levels in February 2015

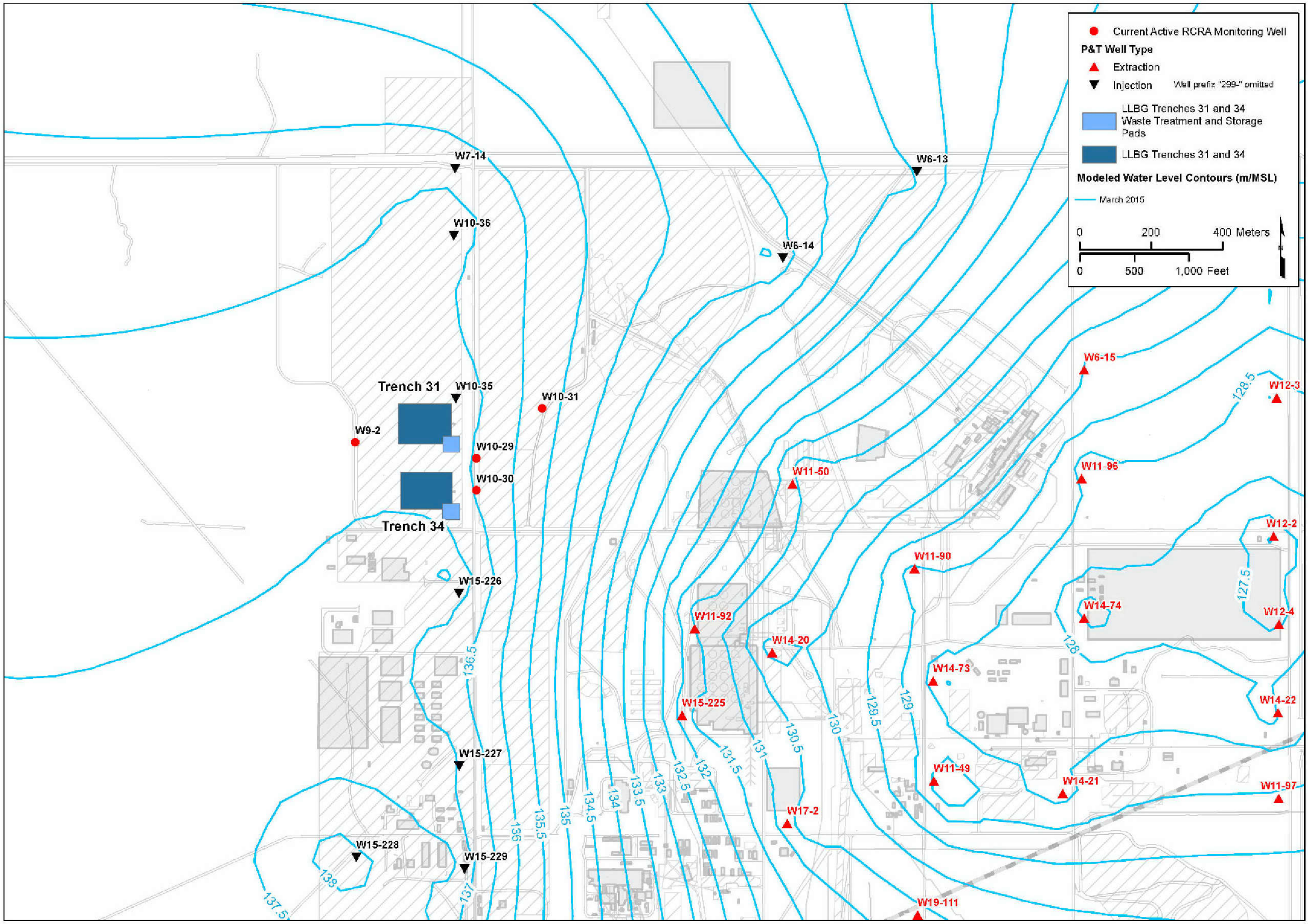

Figure A-3. Simulated Water Levels in March 2015

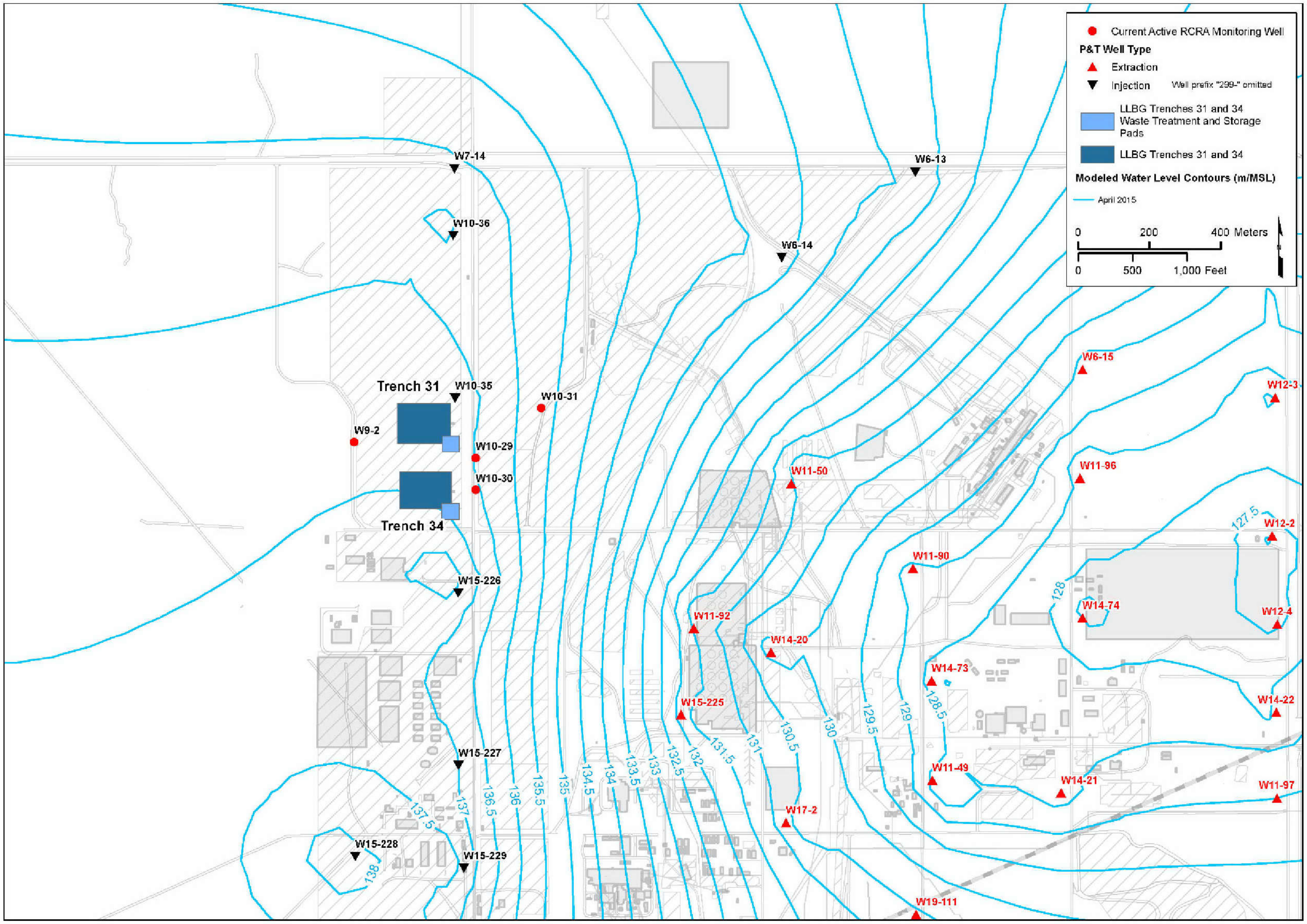

Figure A-4. Simulated Water Levels in April 2015

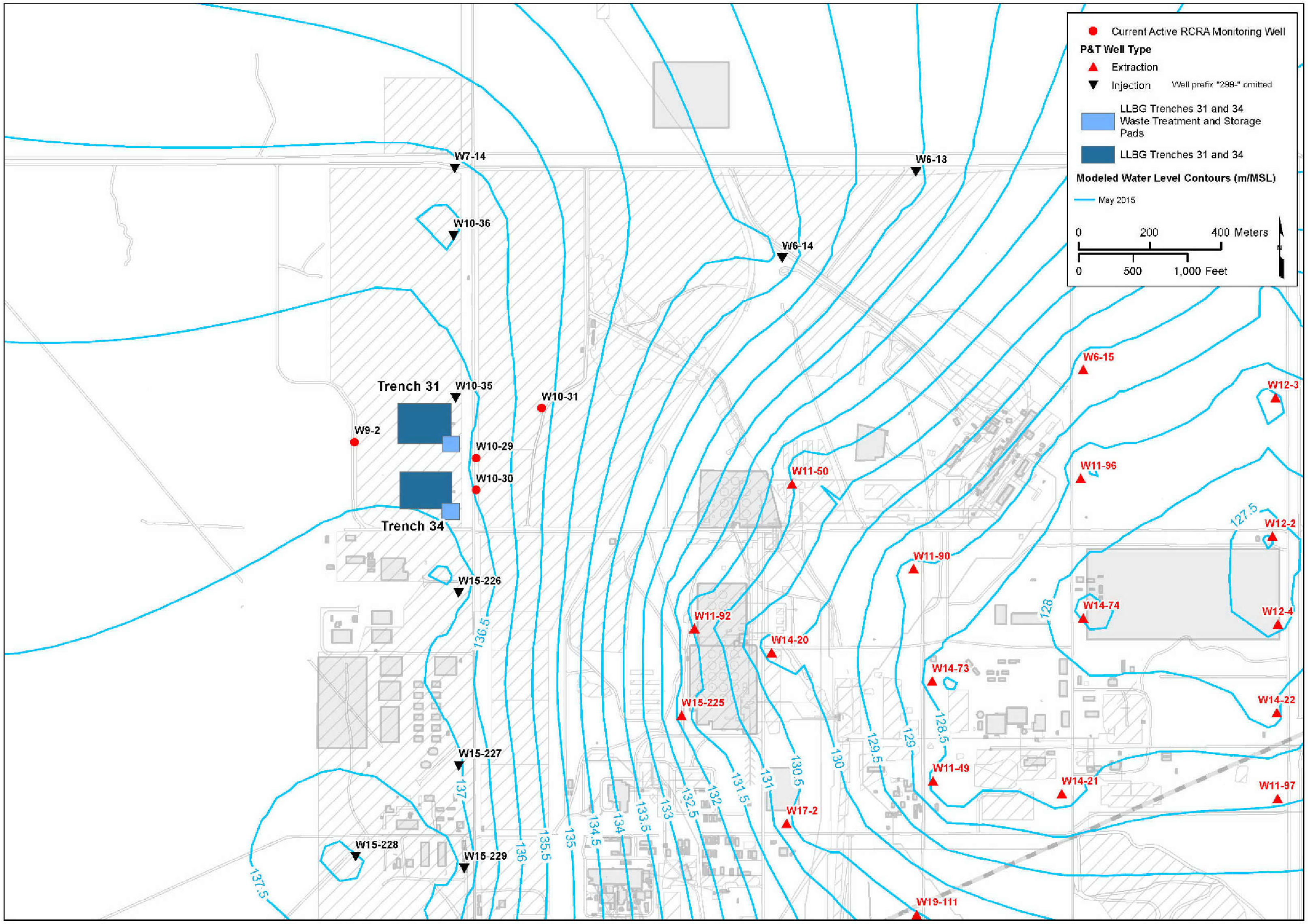

Figure A-5. Simulated Water Levels in May 2015

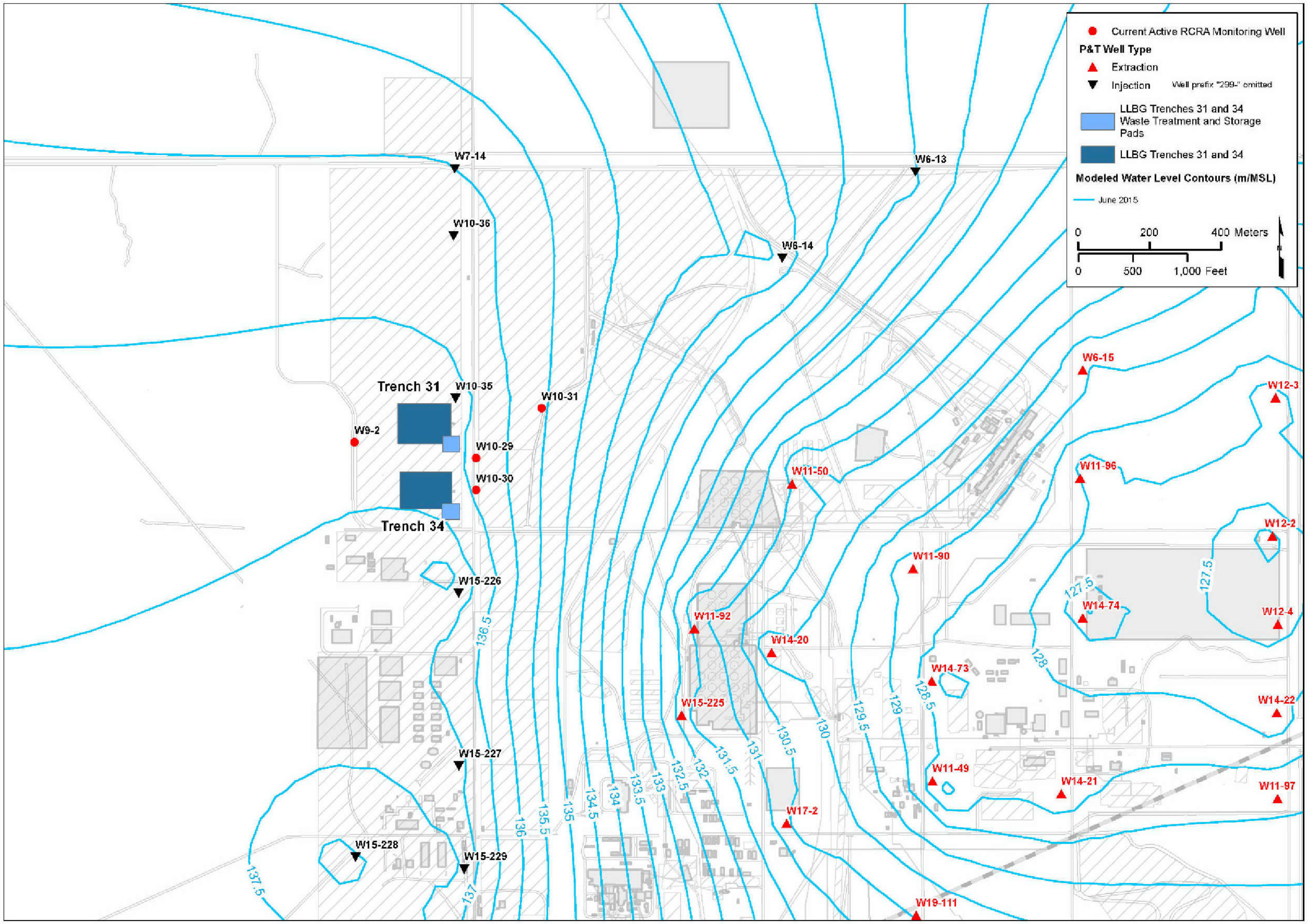

Figure A-6. Simulated Water Levels in June 2015

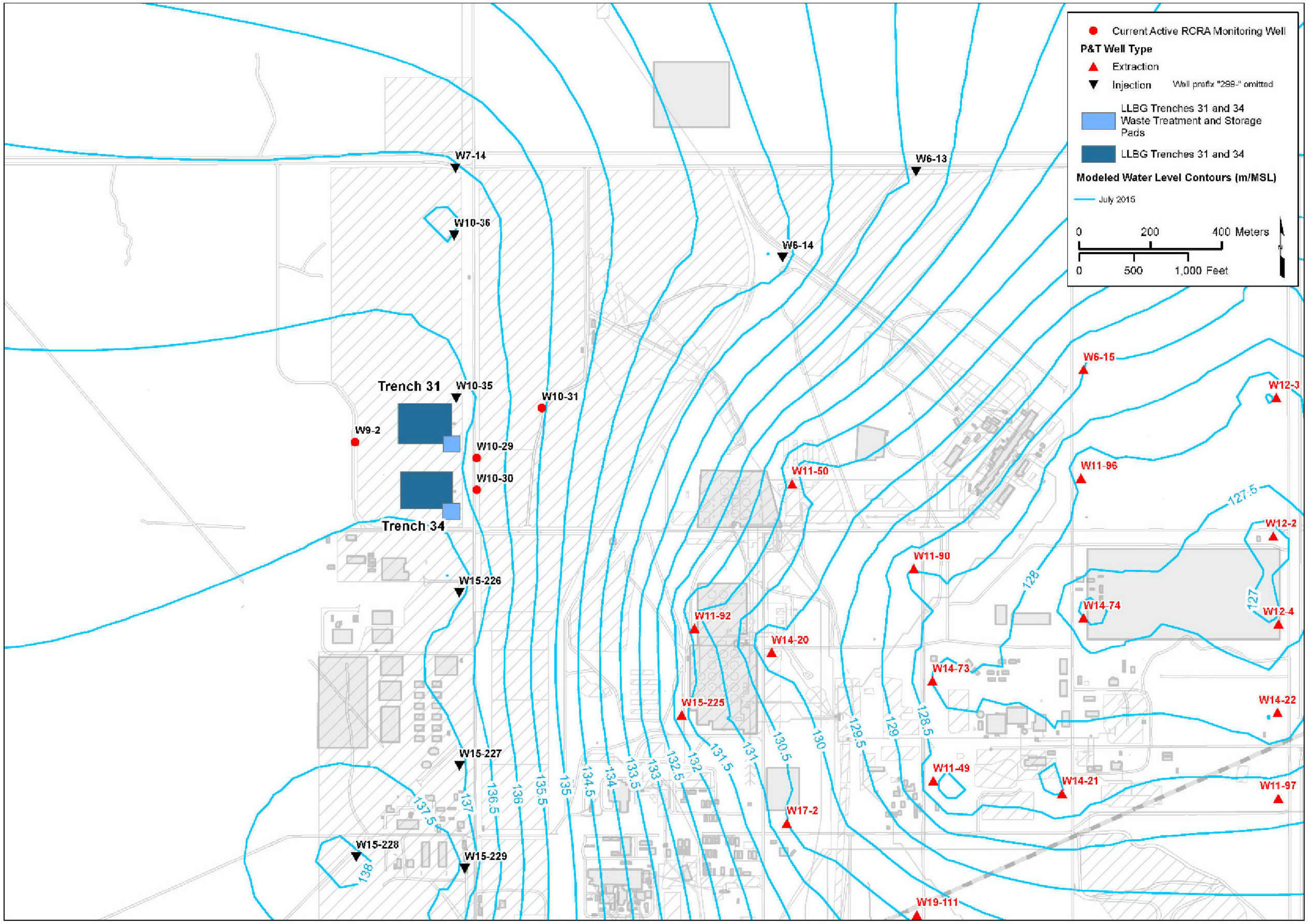

Figure A-7. Simulated Water Levels in July 2015

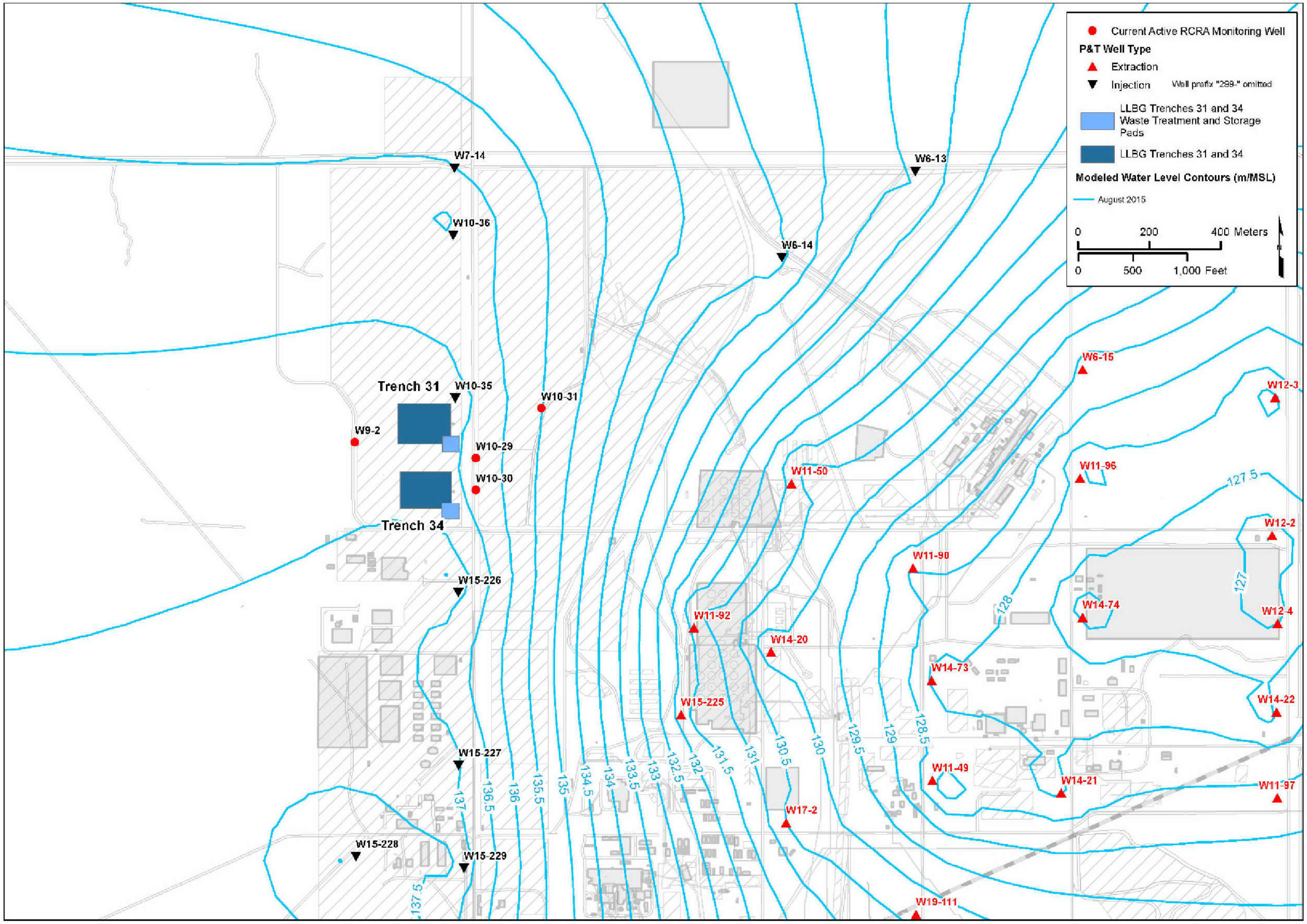

Figure A-8. Simulated Water Levels in August 2015

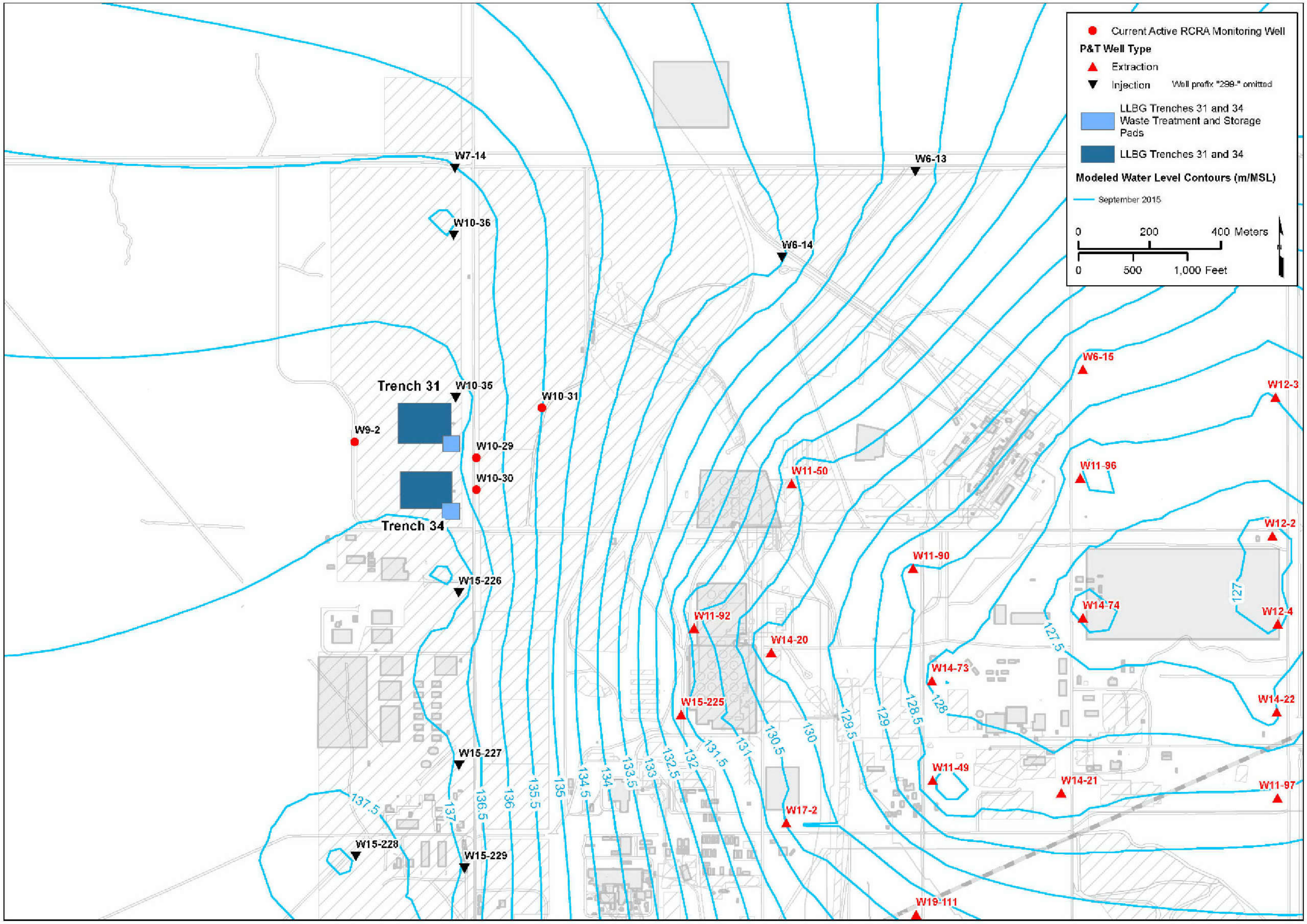

Figure A-9. Simulated Water Levels in September 2015

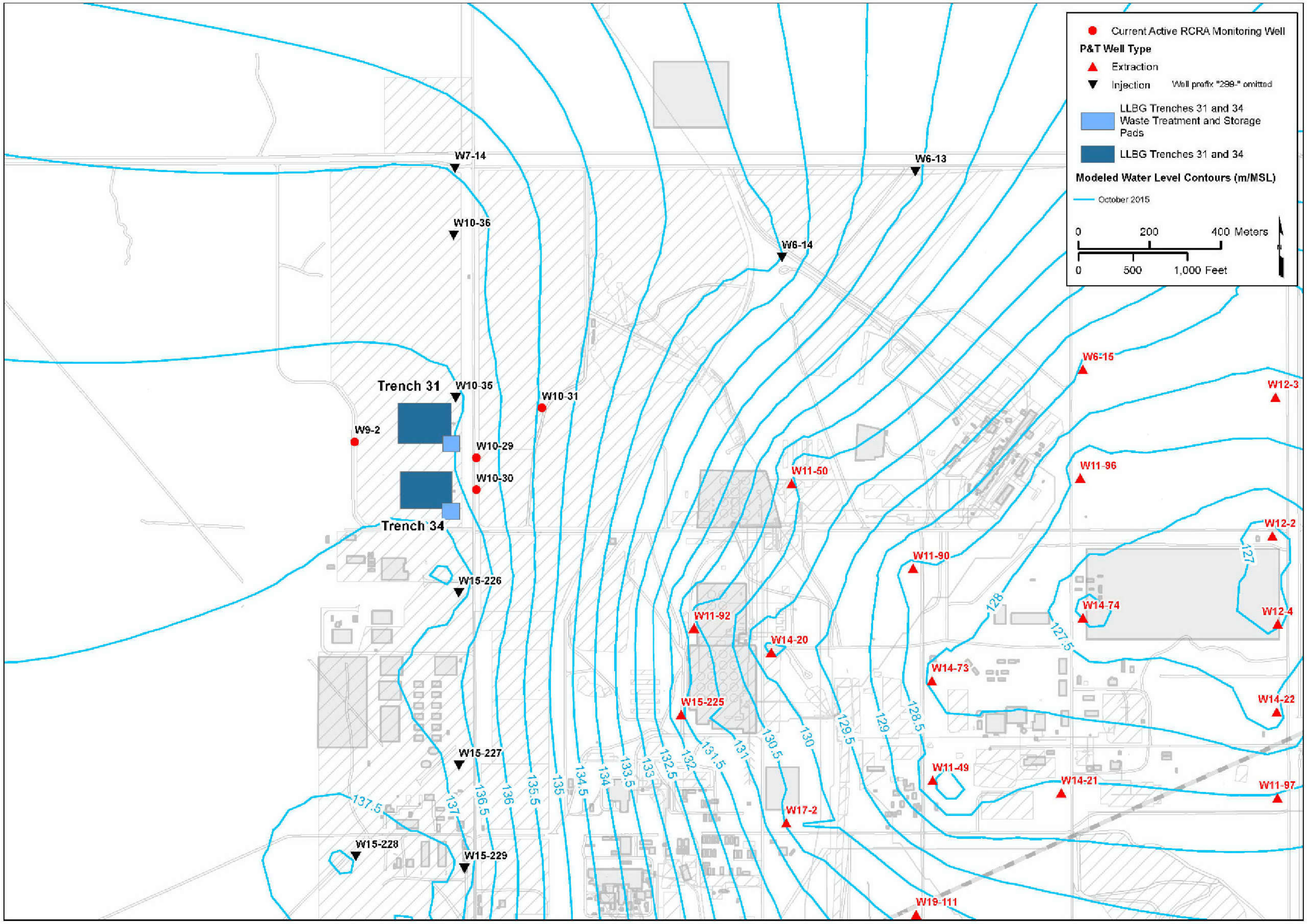

Figure A-10. Simulated Water Levels in October 2015

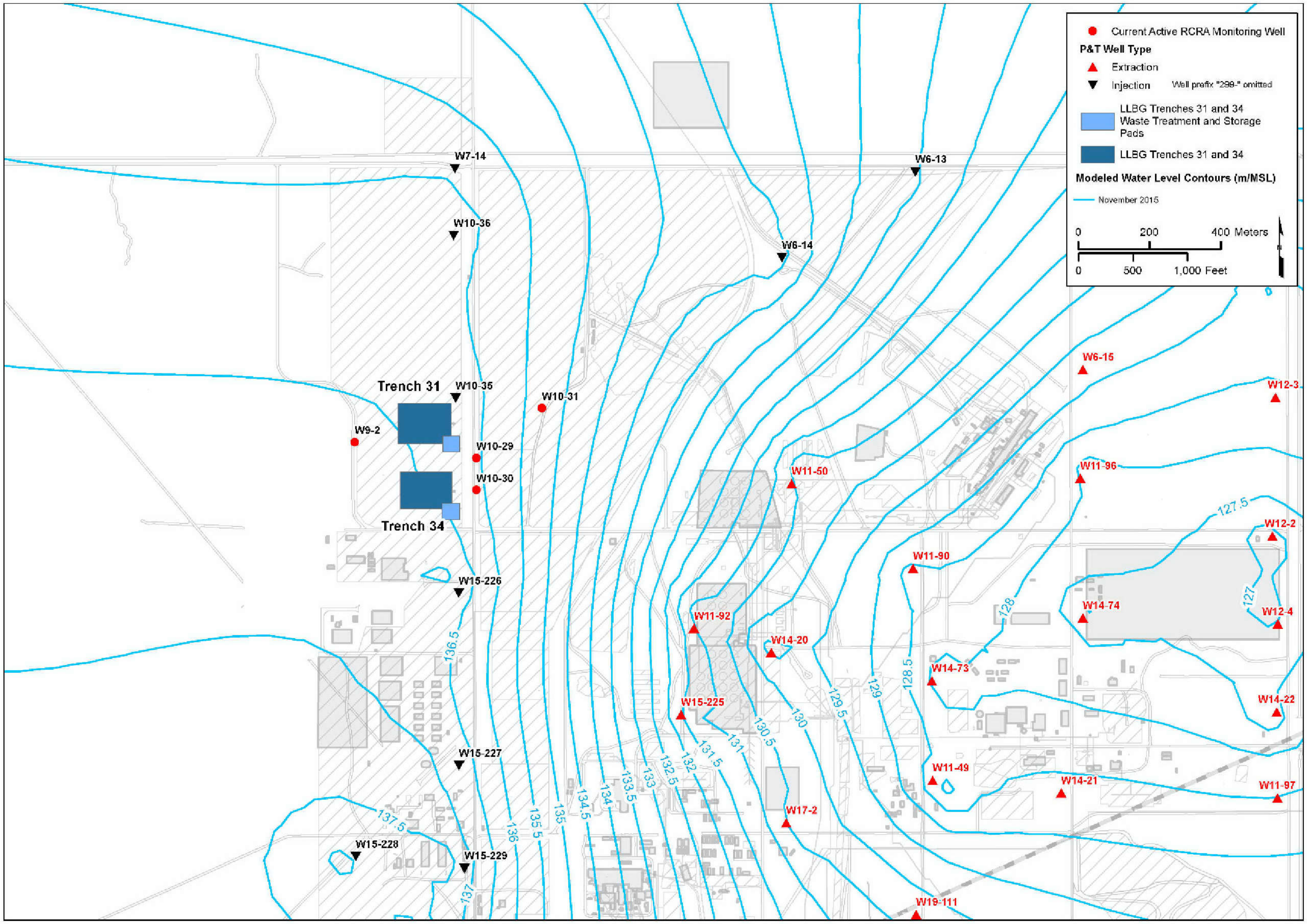

Figure A-11. Simulated Water Levels in November 2015

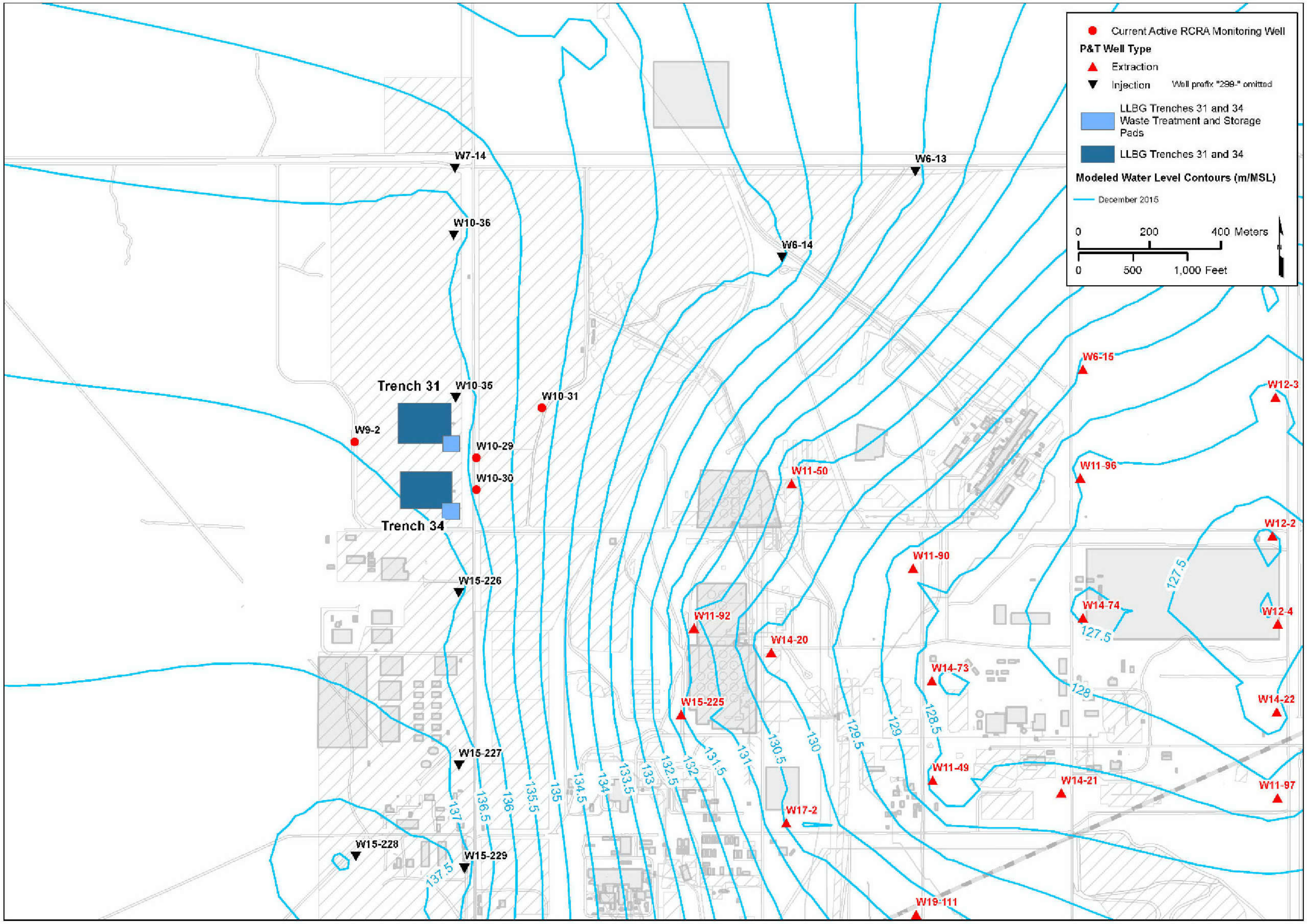

Figure A-12. Simulated Water Levels in December 2015

Appendix B

Mapped Water Level Maps

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Figures

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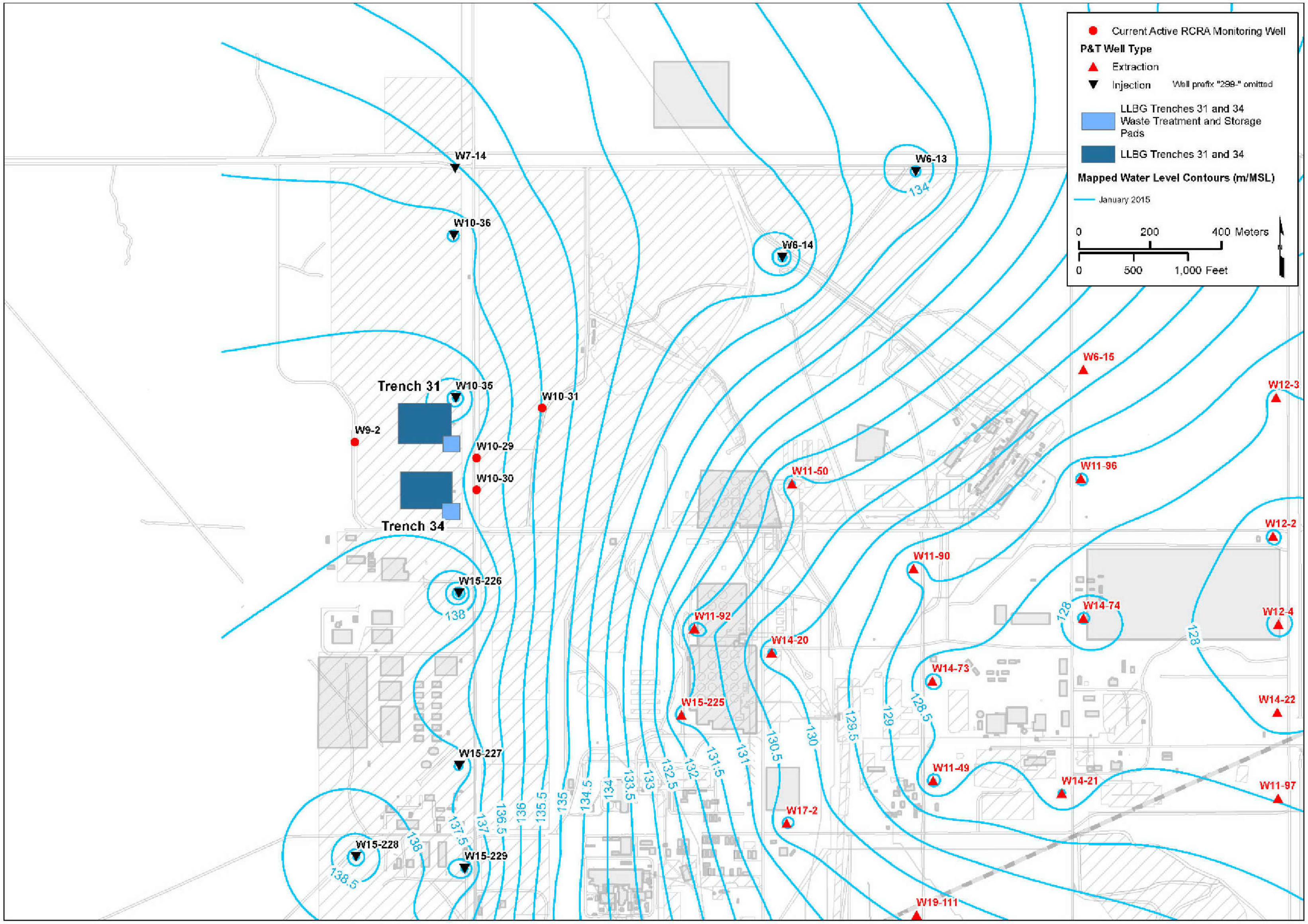
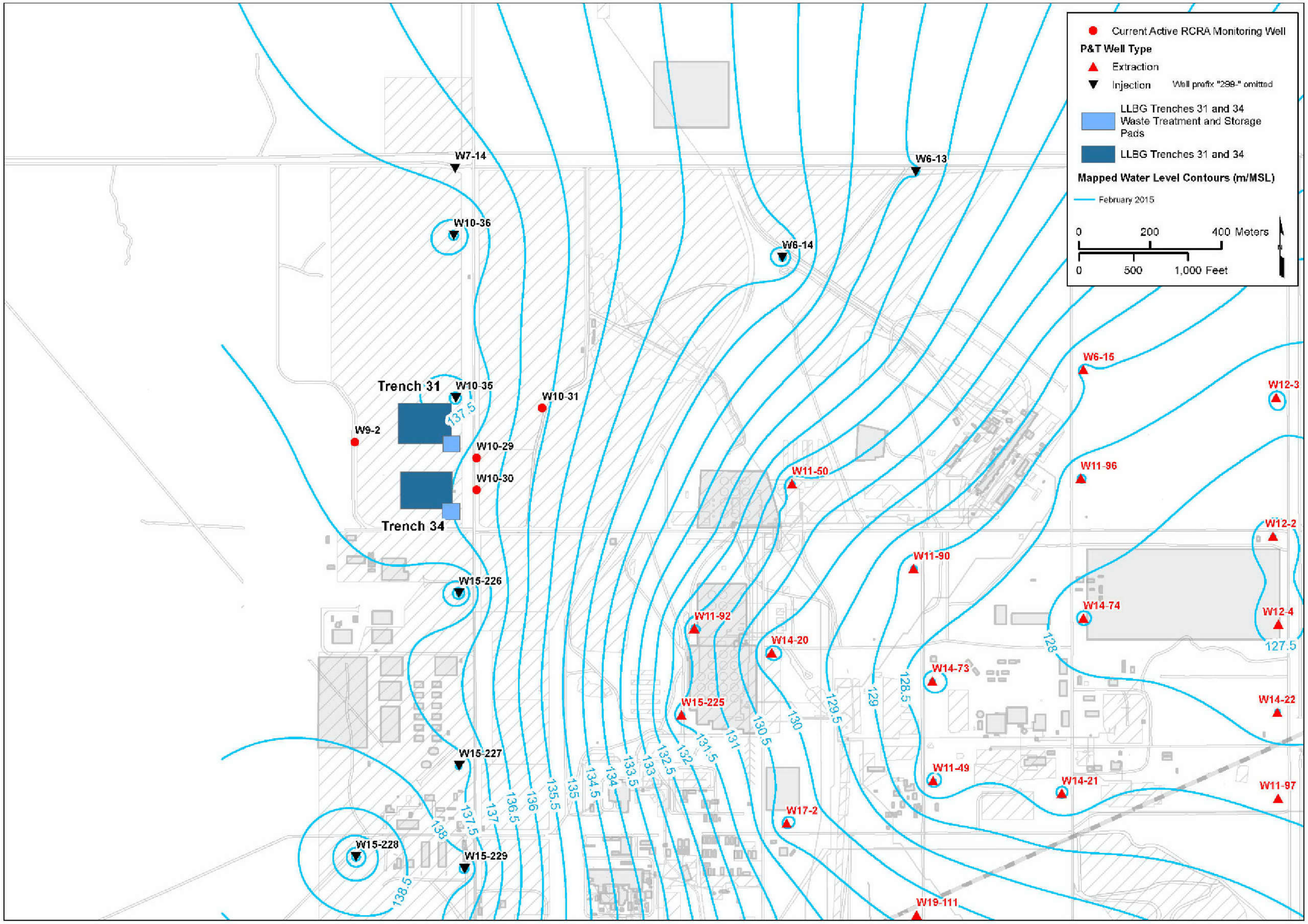


Figure B-1. Mapped Water Levels in January 2015



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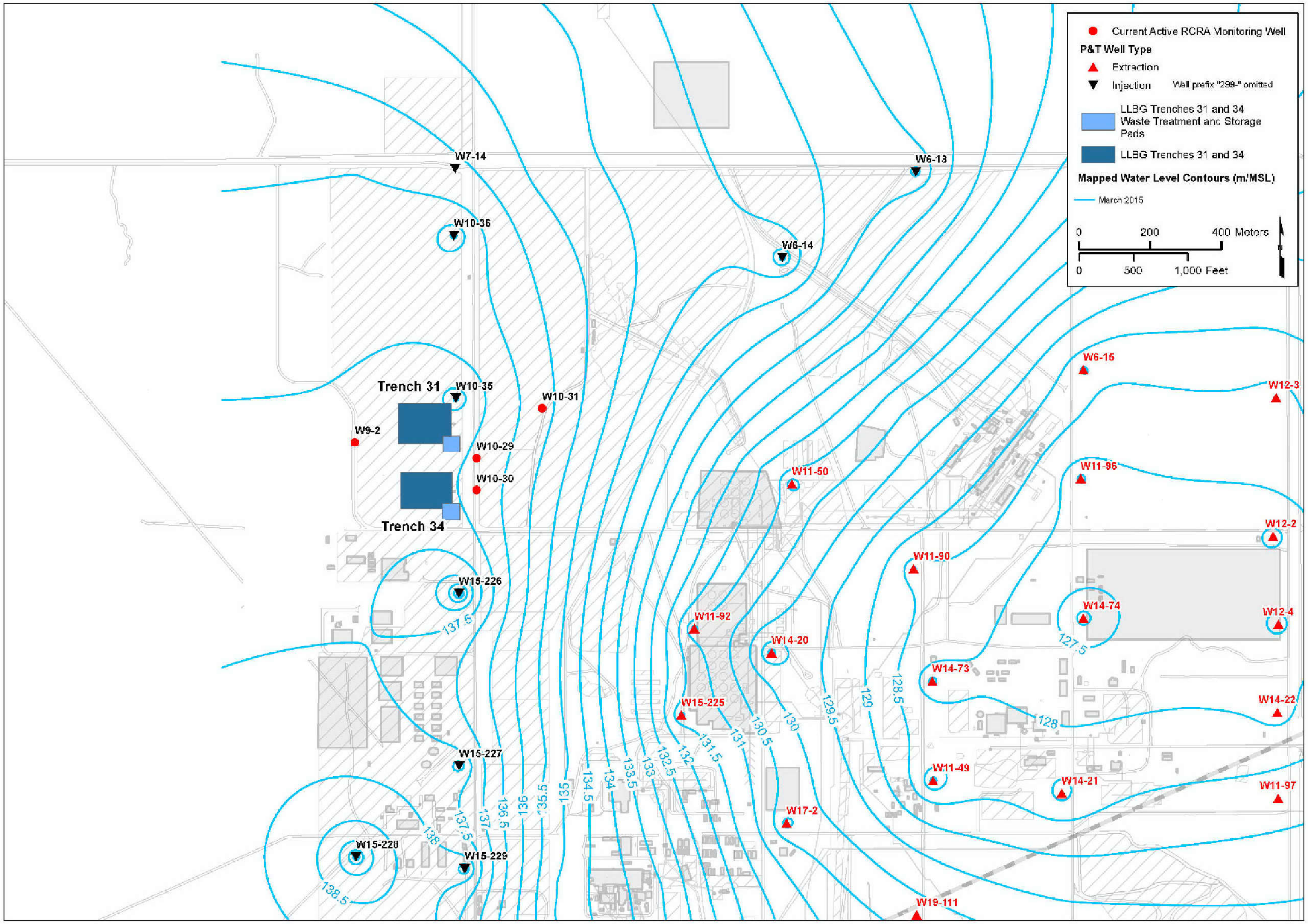

Figure B-3. Mapped Water Levels in March 2015

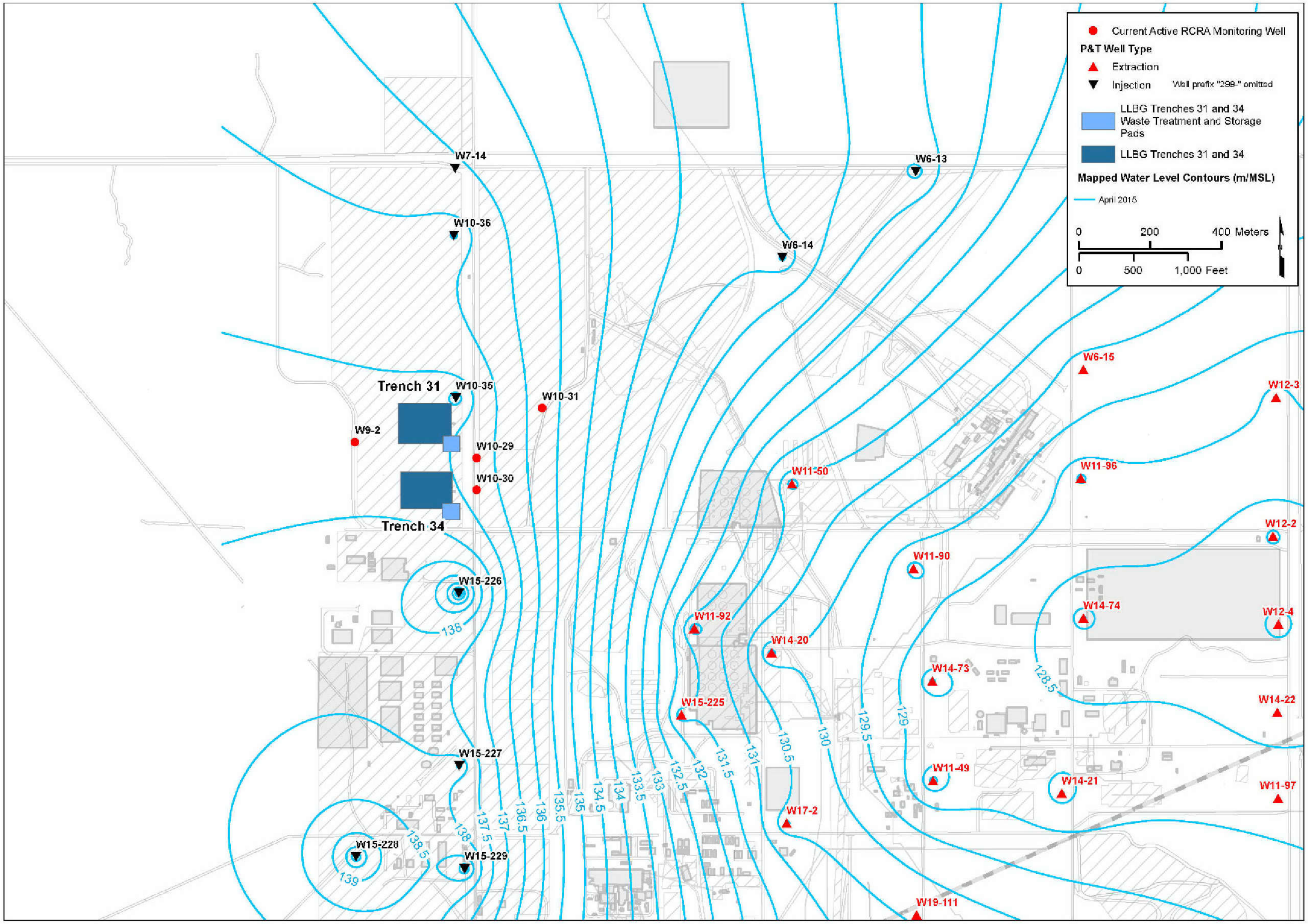

Figure B-4. Mapped Water Levels in April 2015

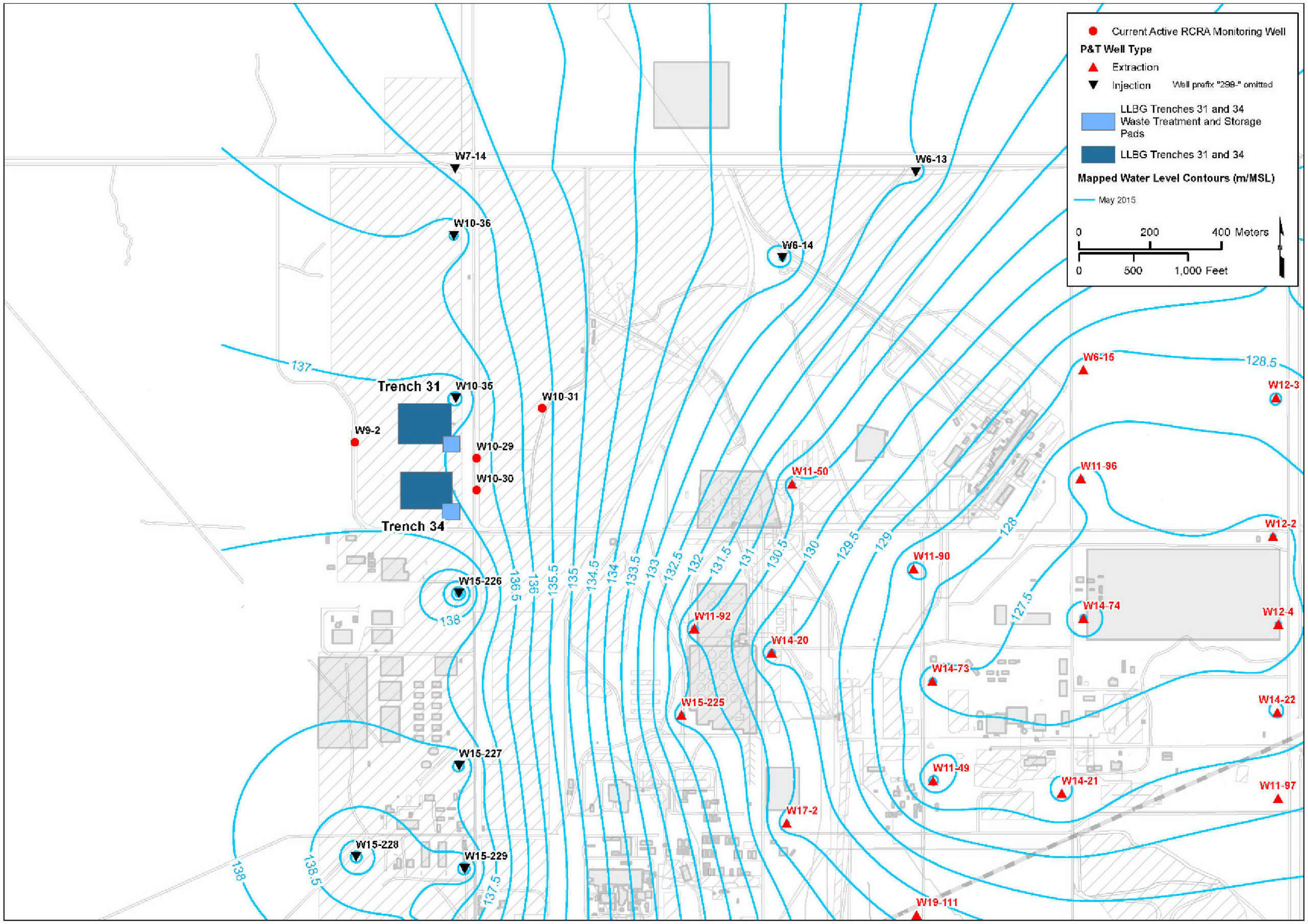

Figure B-5. Mapped Water Levels in May 2015

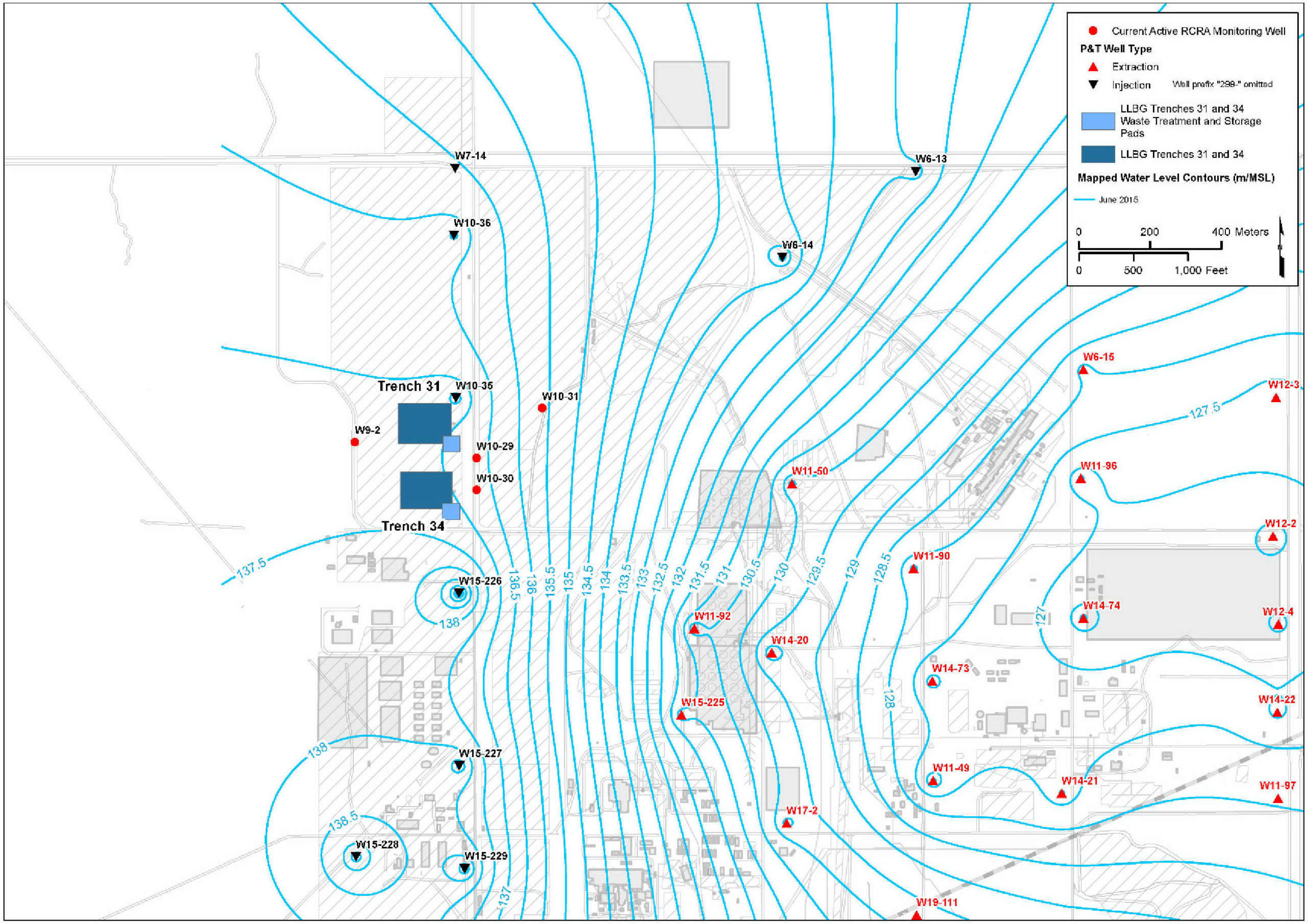

Figure B-6. Mapped Water Levels in June 2015

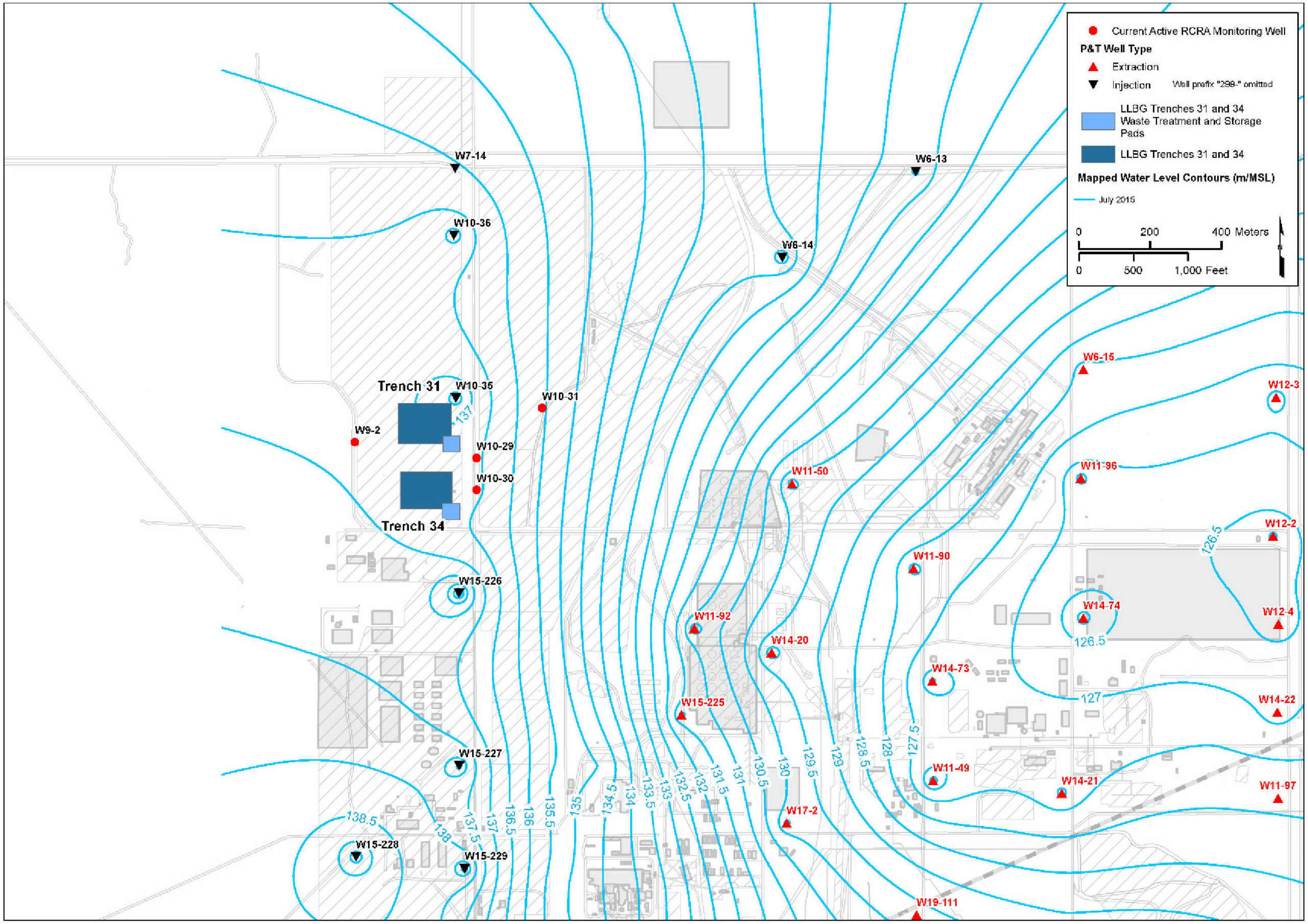

Figure B-7. Mapped Water Levels in July 2015

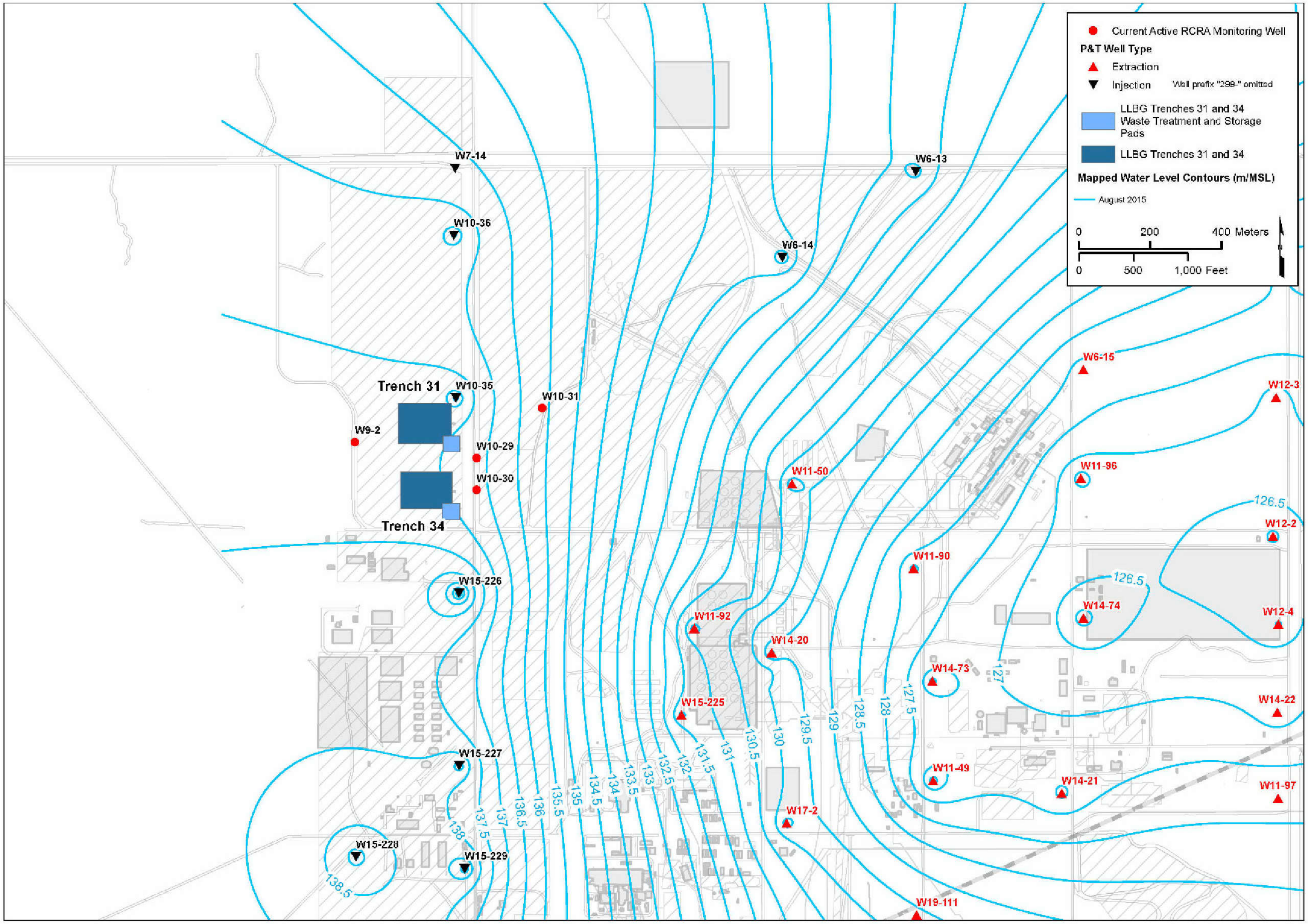

Figure B-8. Mapped Water Levels in August 2015

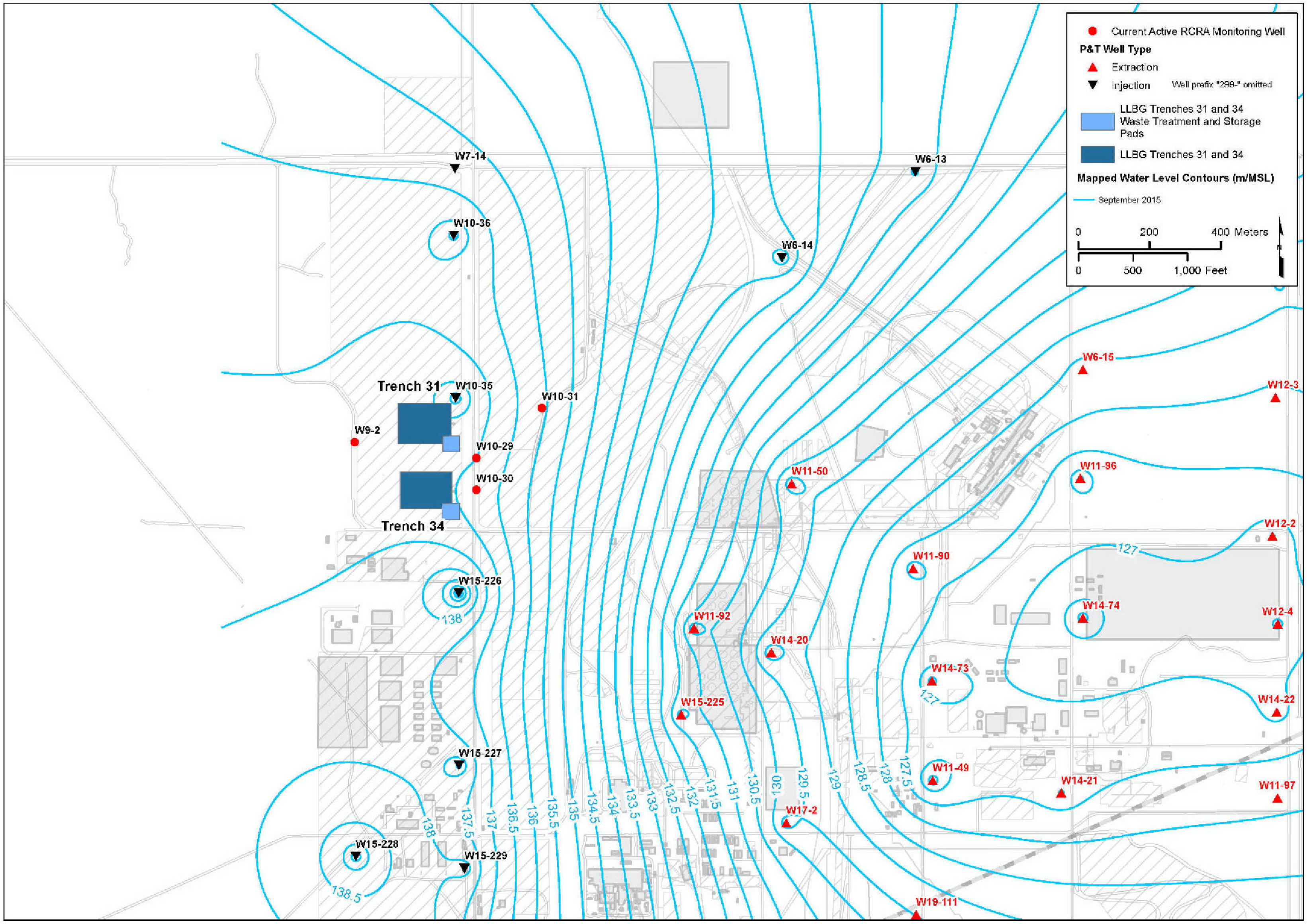

Figure B-9. Mapped Water Levels in September 2015

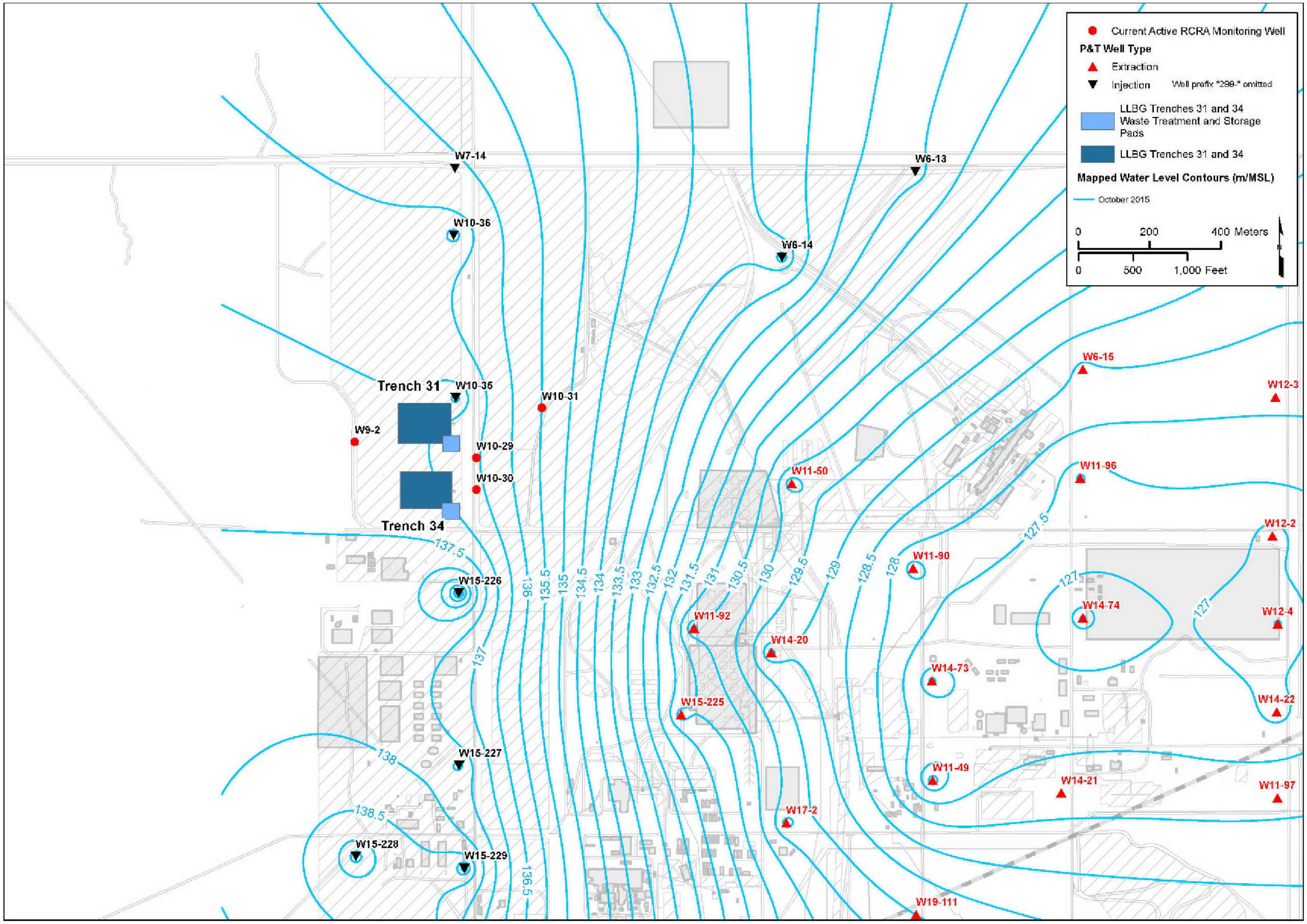

Figure B-10. Mapped Water Levels in October 2015

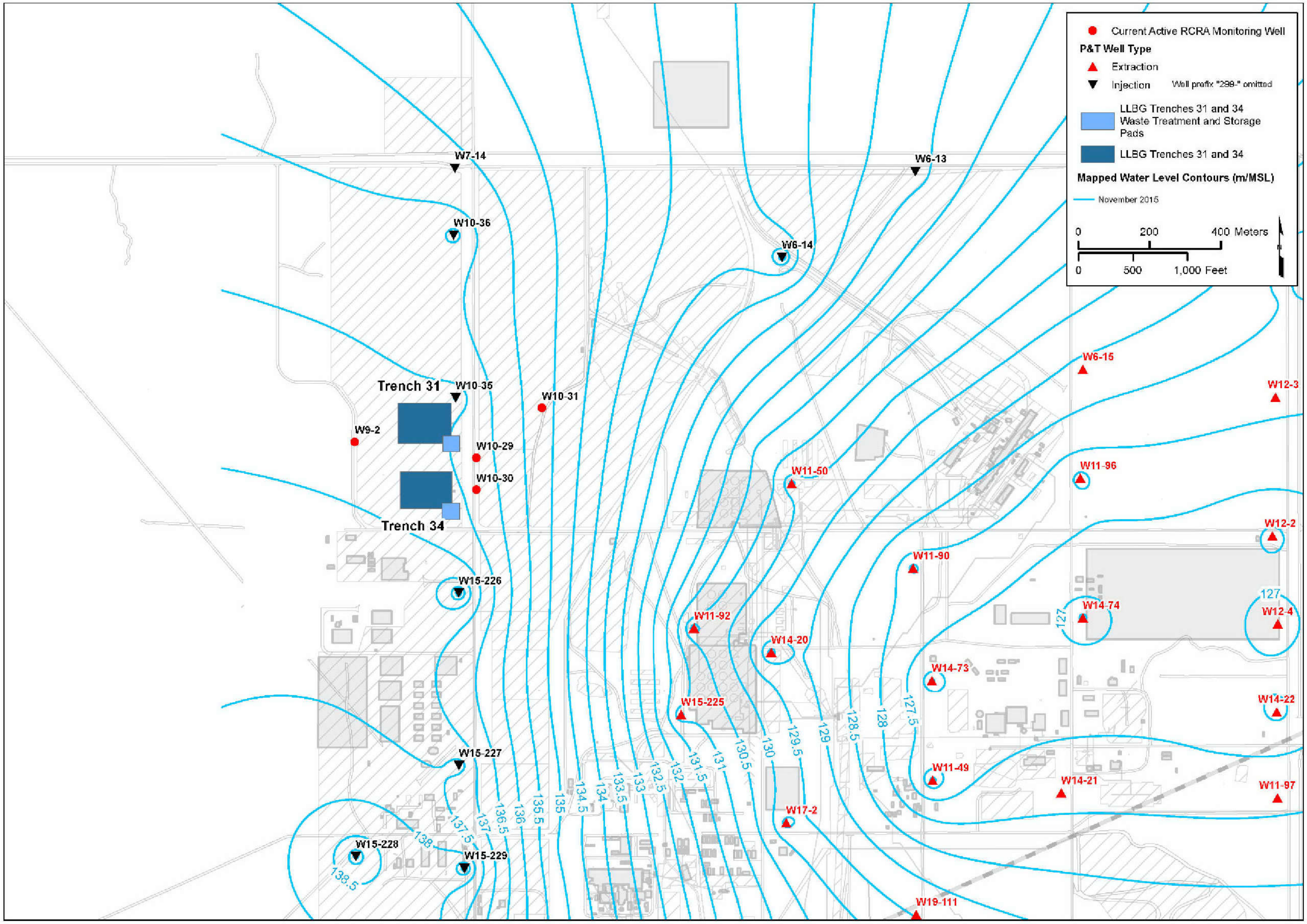

Figure B-11. Mapped Water Levels in November 2015

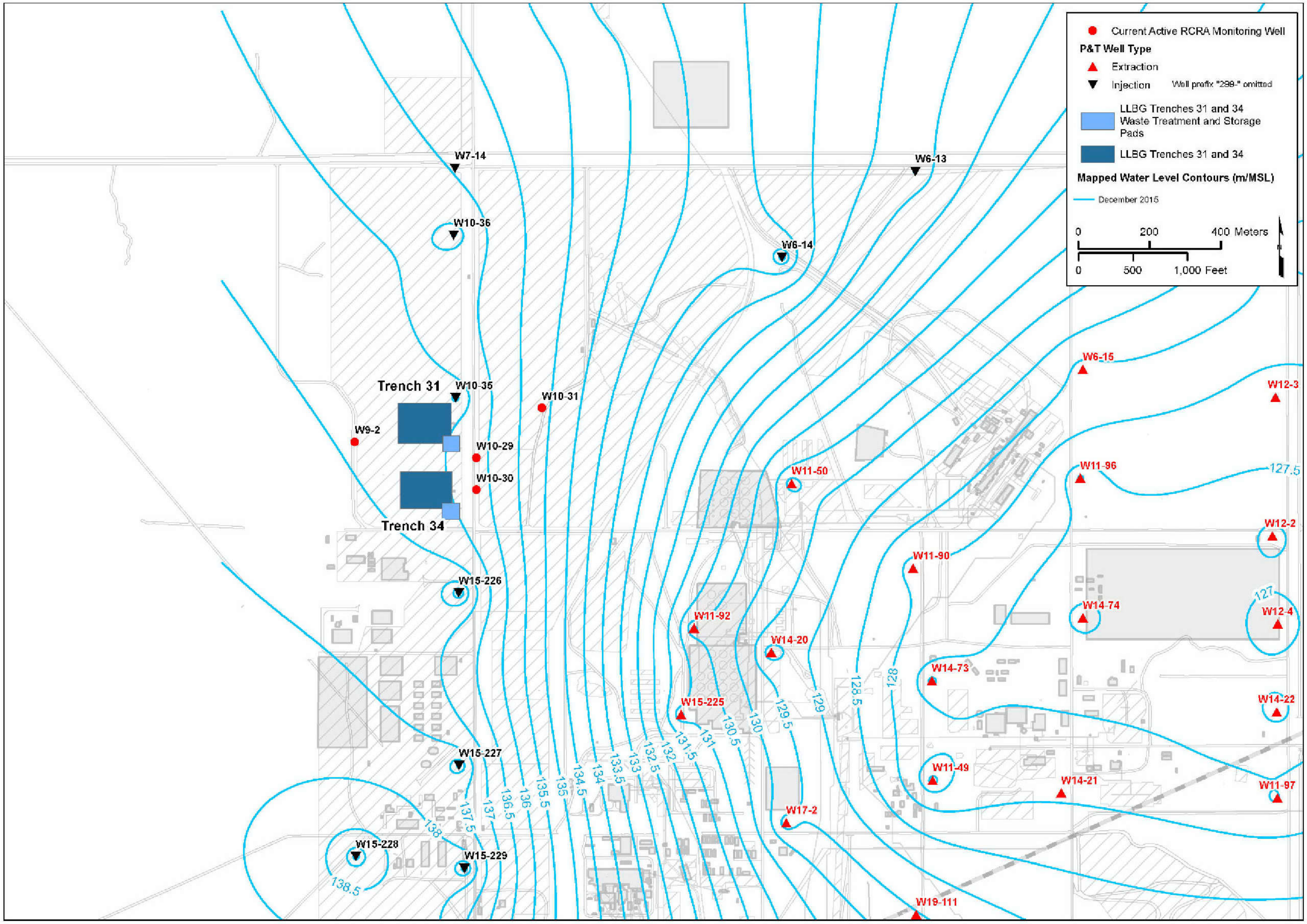

Figure B-12. Mapped Water Levels in December 2015

Appendix C

Particle Count Maps

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Figures

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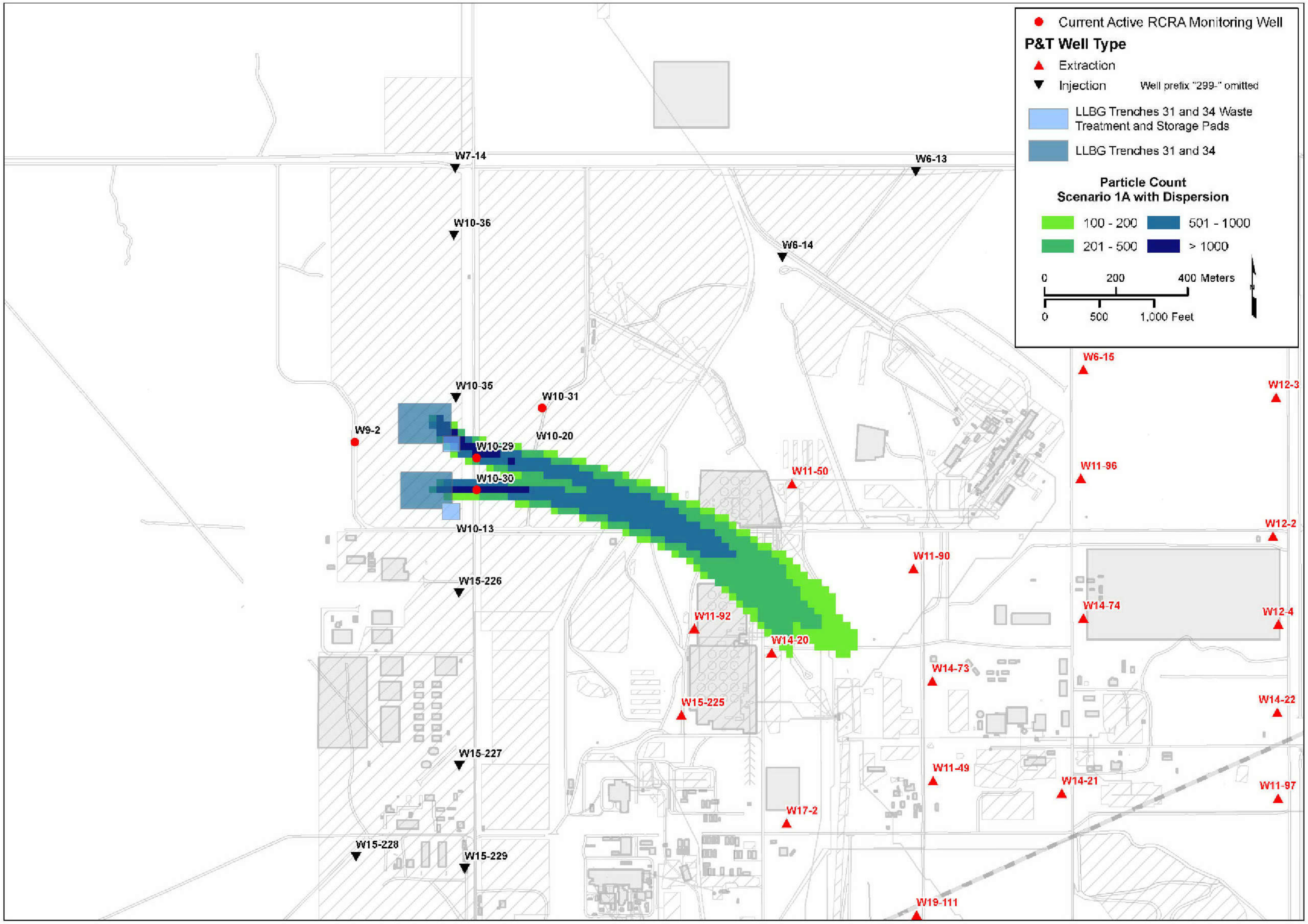

Figure C-1. Particle Count Scenario 1A with Dispersion

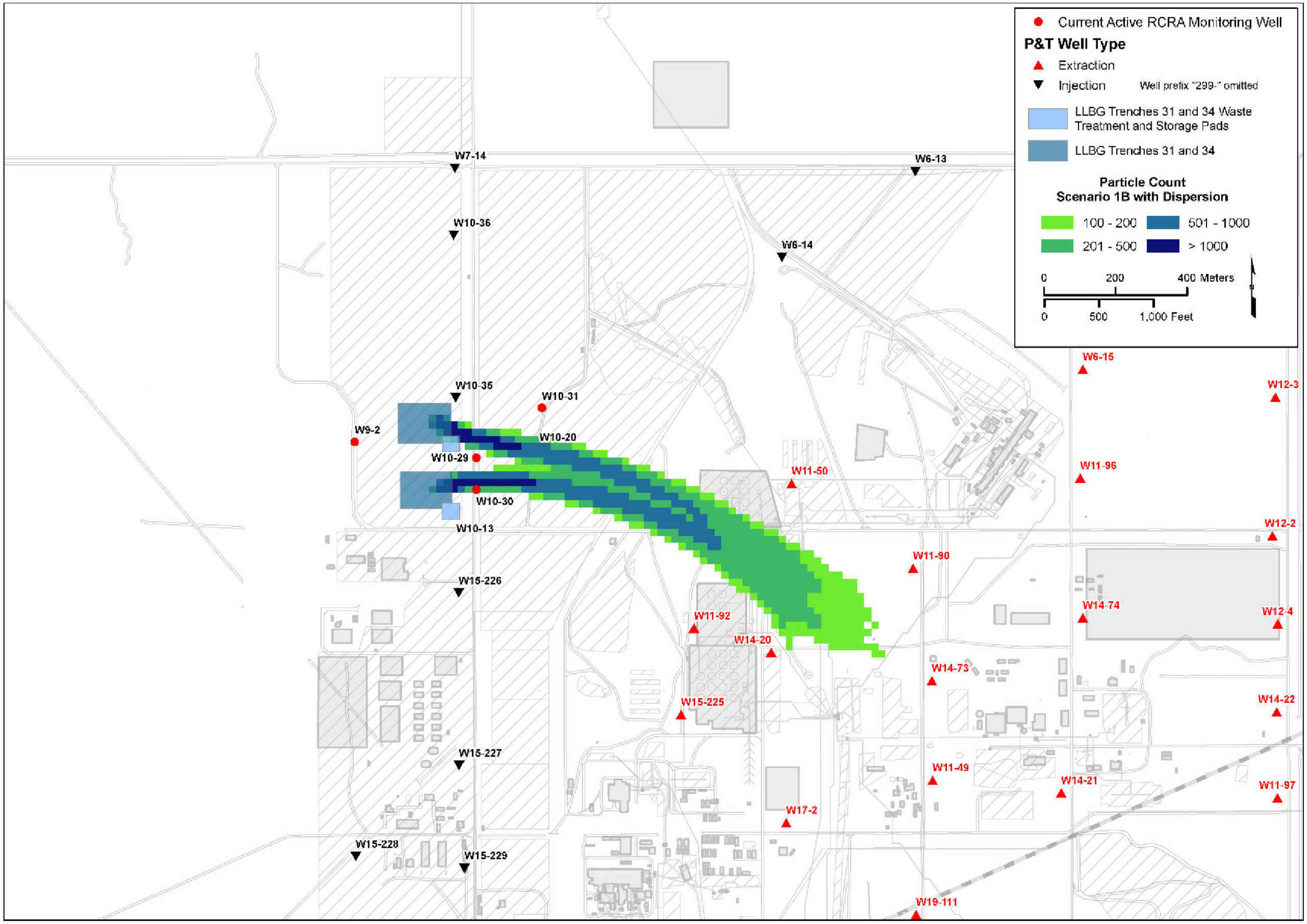

Figure C-2. Particle Count Scenario 1B with Dispersion

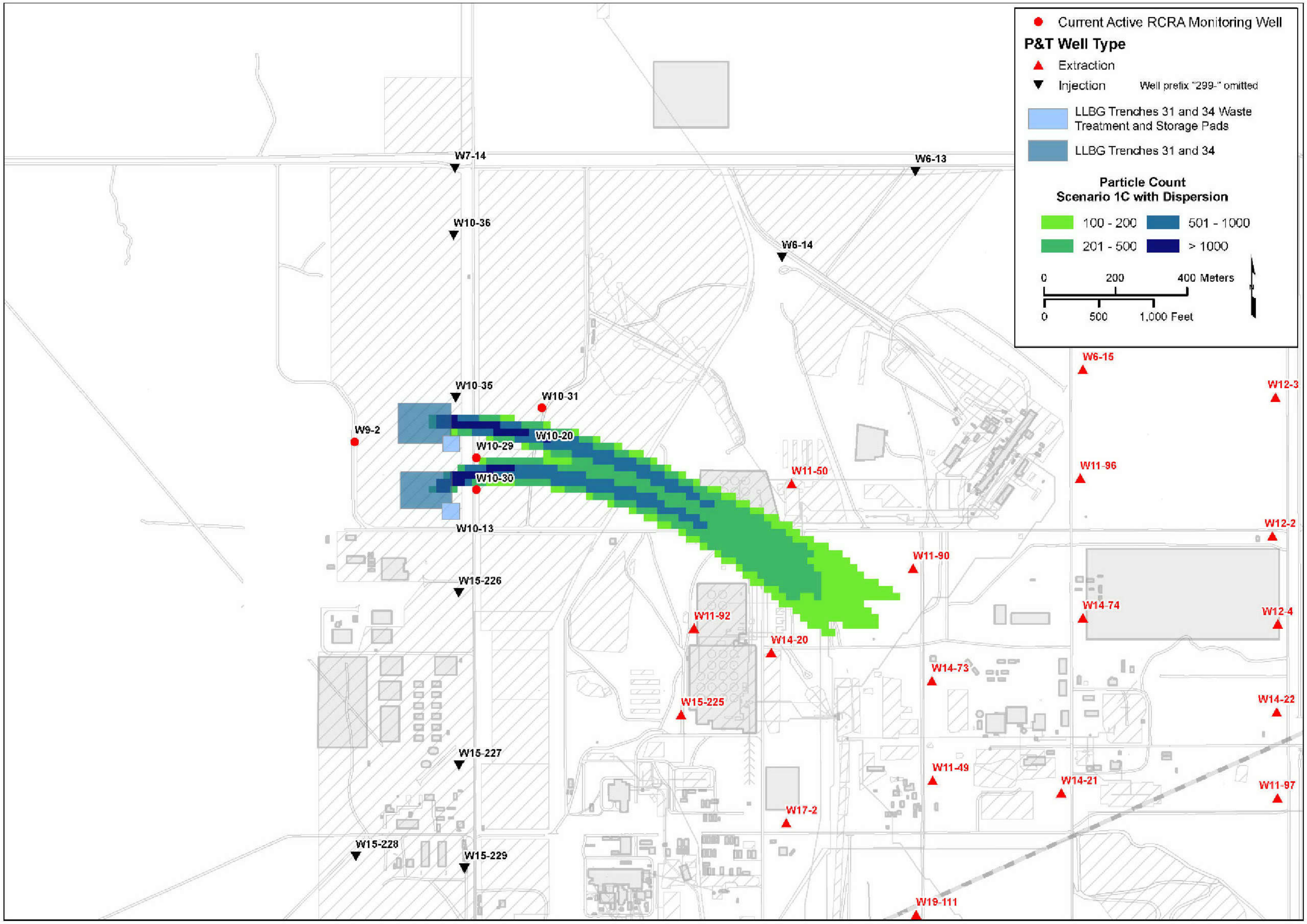

Figure C-3. Particle Count Scenario 1C with Dispersion

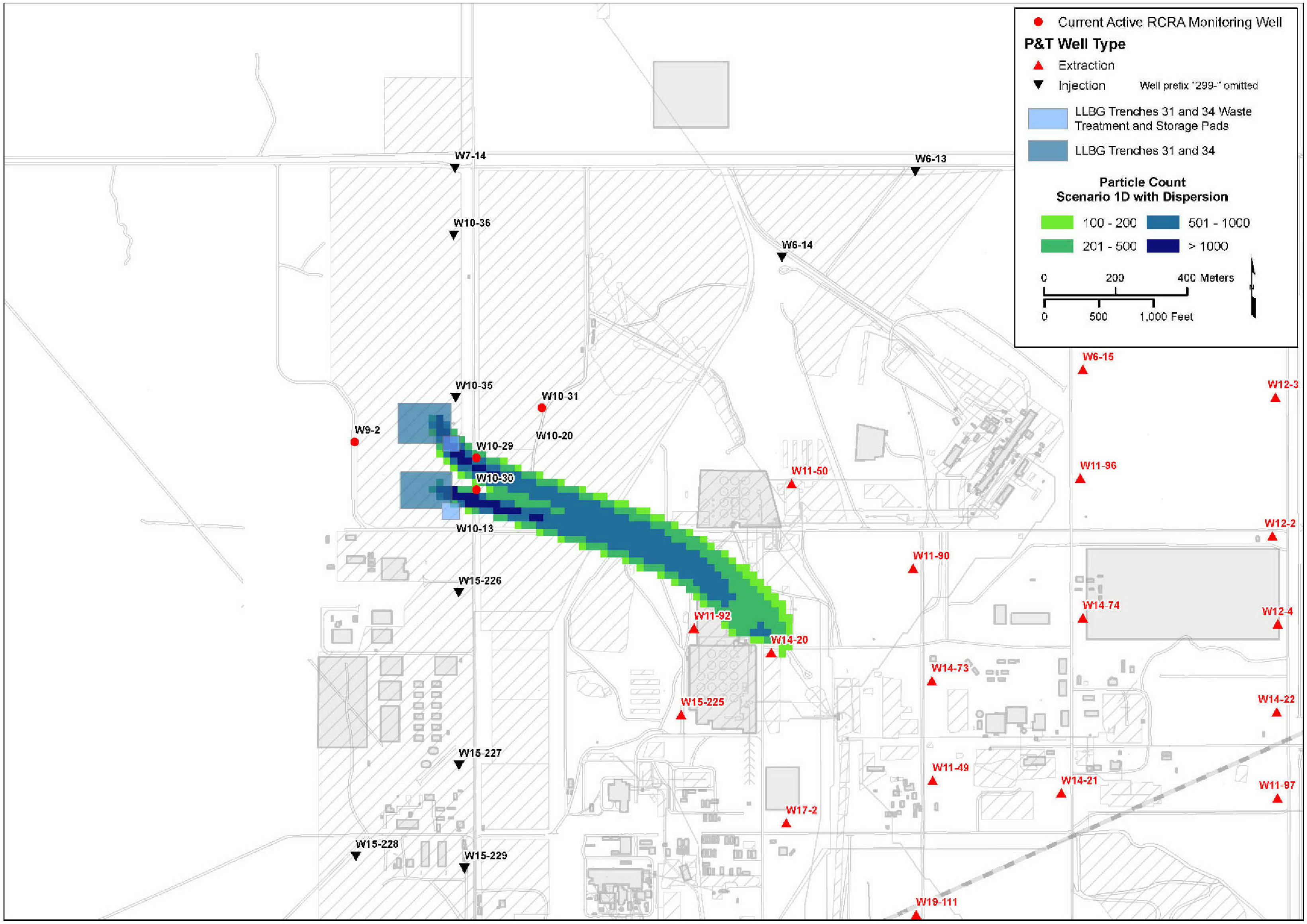

Figure C-4. Particle Count Scenario 1D with Dispersion

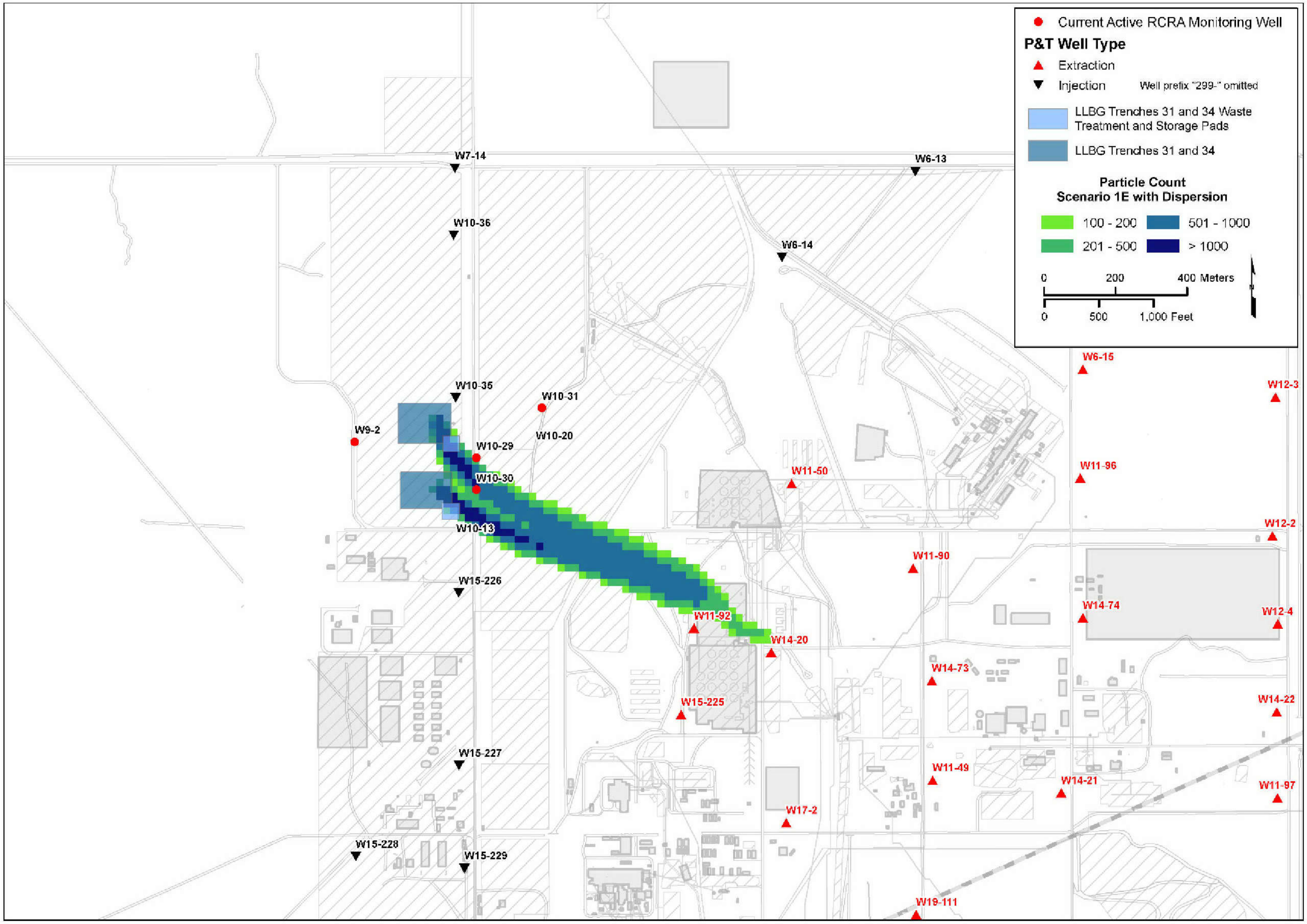

Figure C-5. Particle Count Scenario 1E with Dispersion

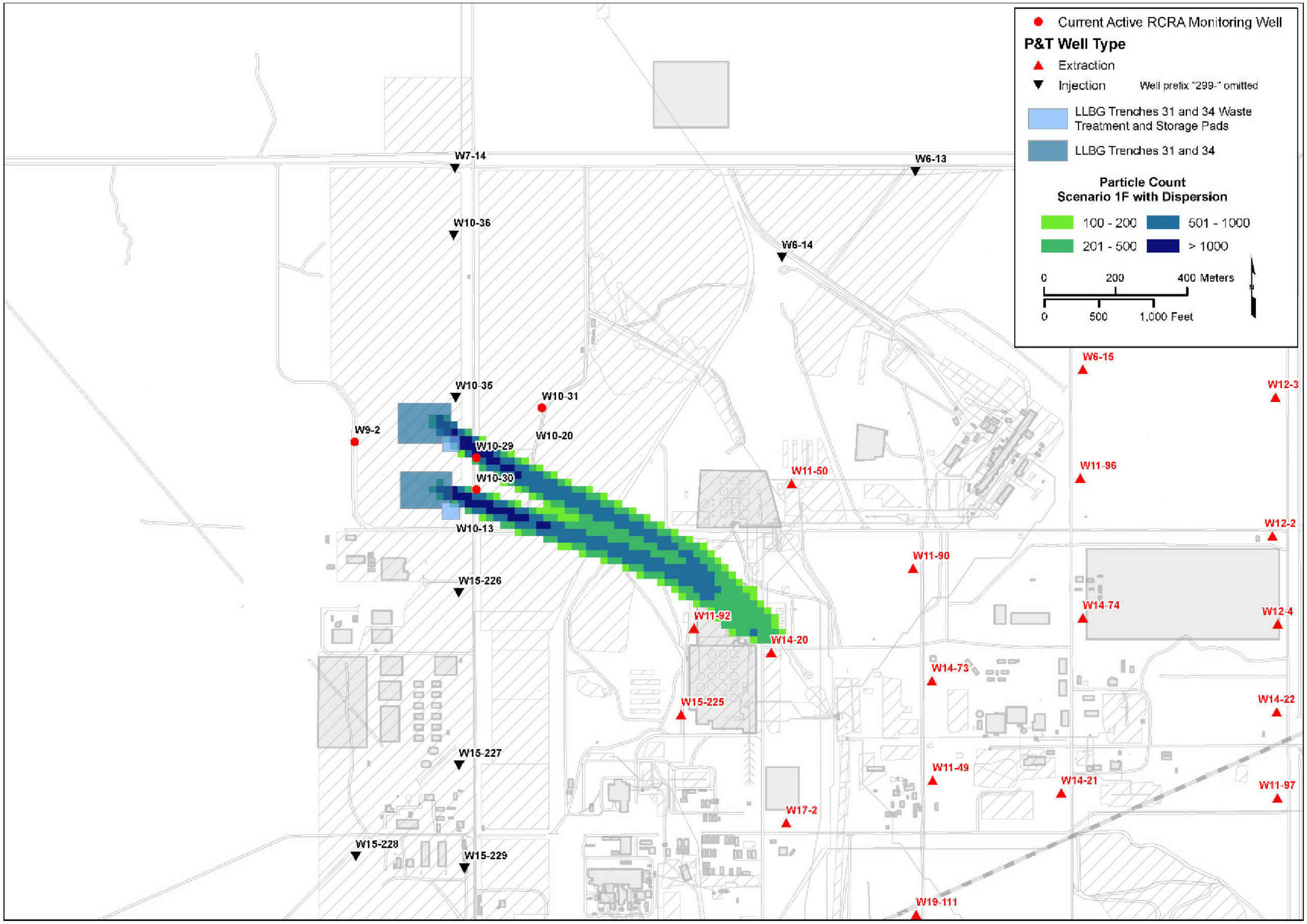

Figure C-6. Particle Count Scenario 1F with Dispersion

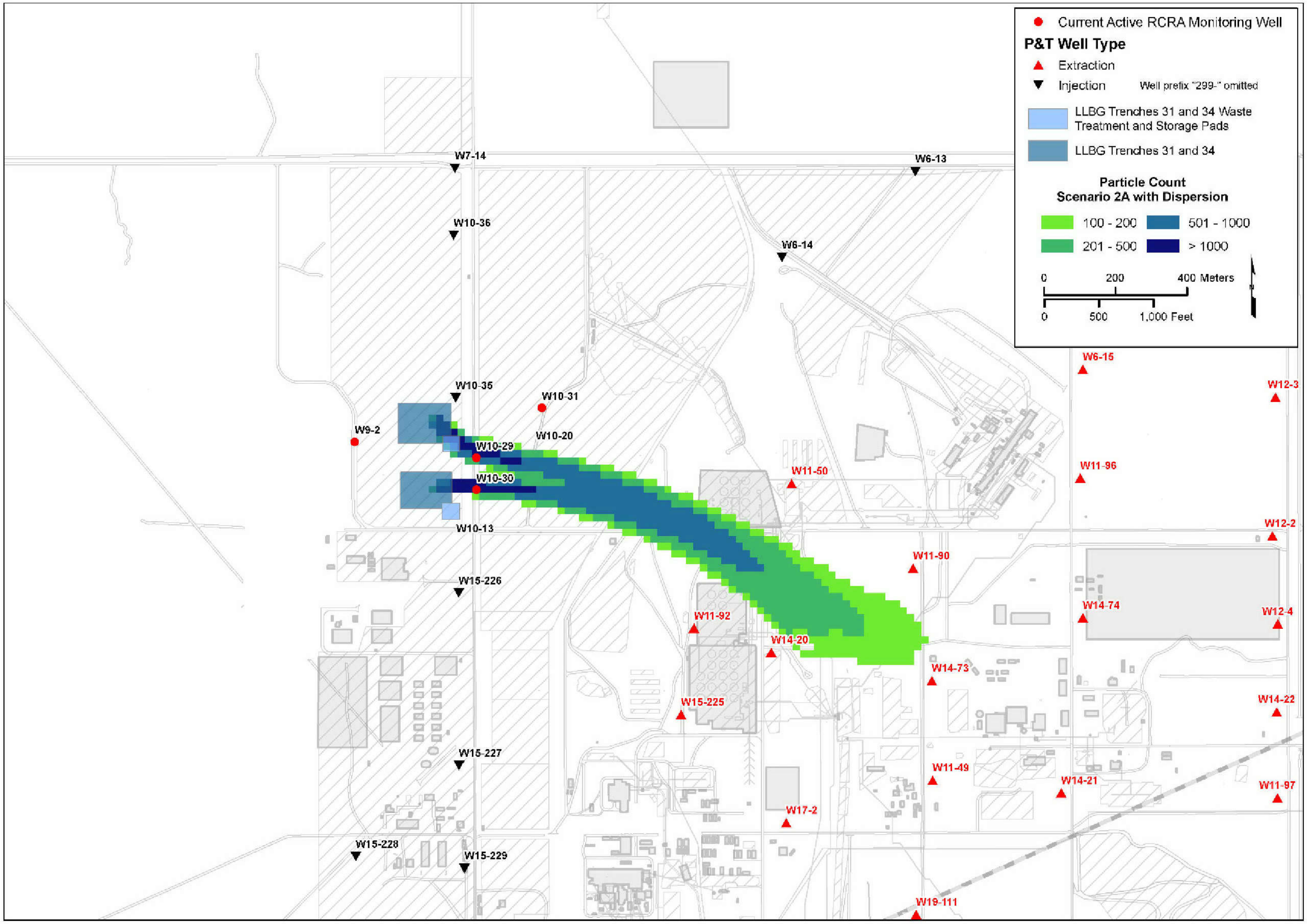

Figure C-7. Particle Count Scenario 2A with Dispersion

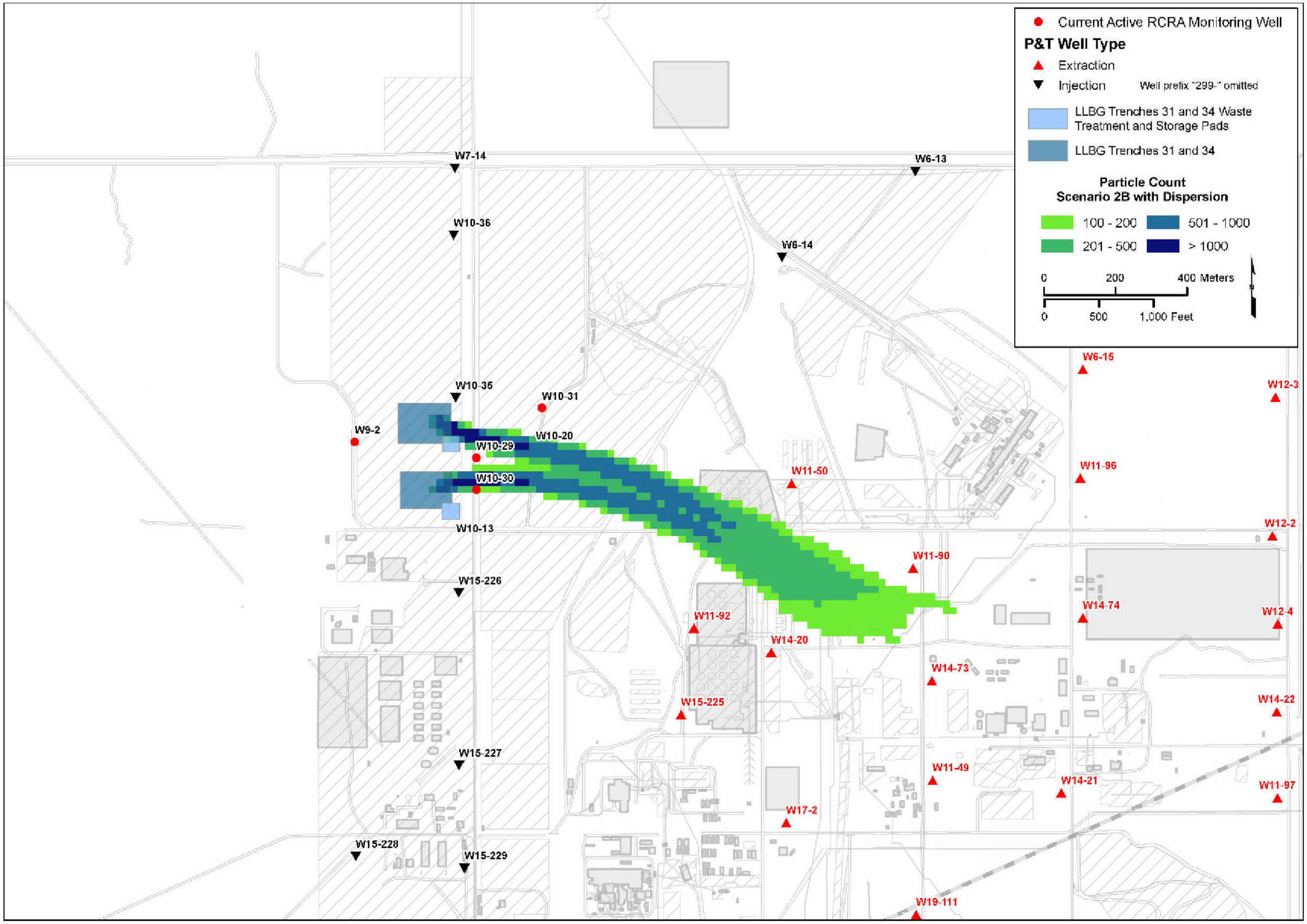

Figure C-8. Particle Count Scenario 2B with Dispersion

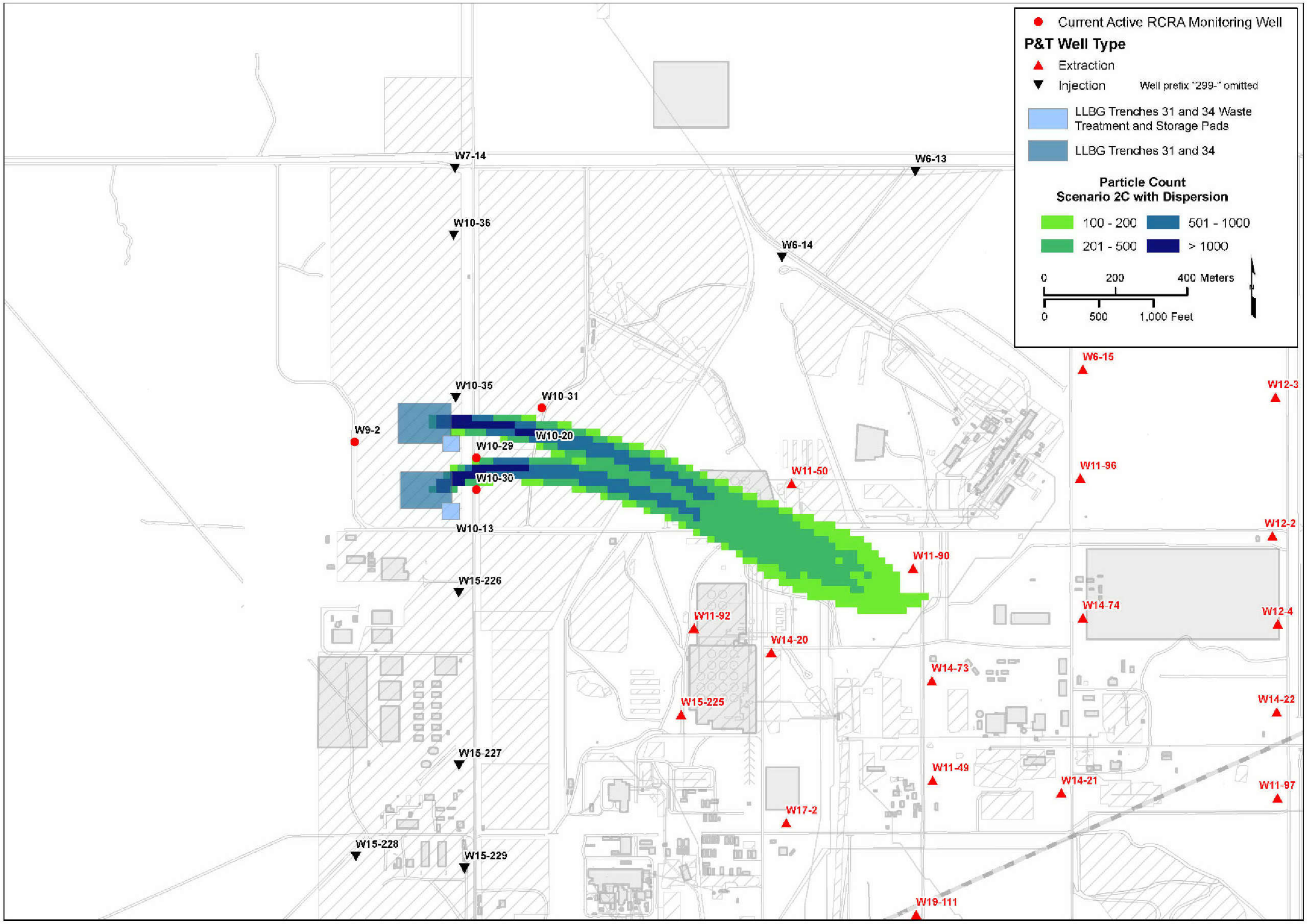

Figure C-9. Particle Count Scenario 2C with Dispersion

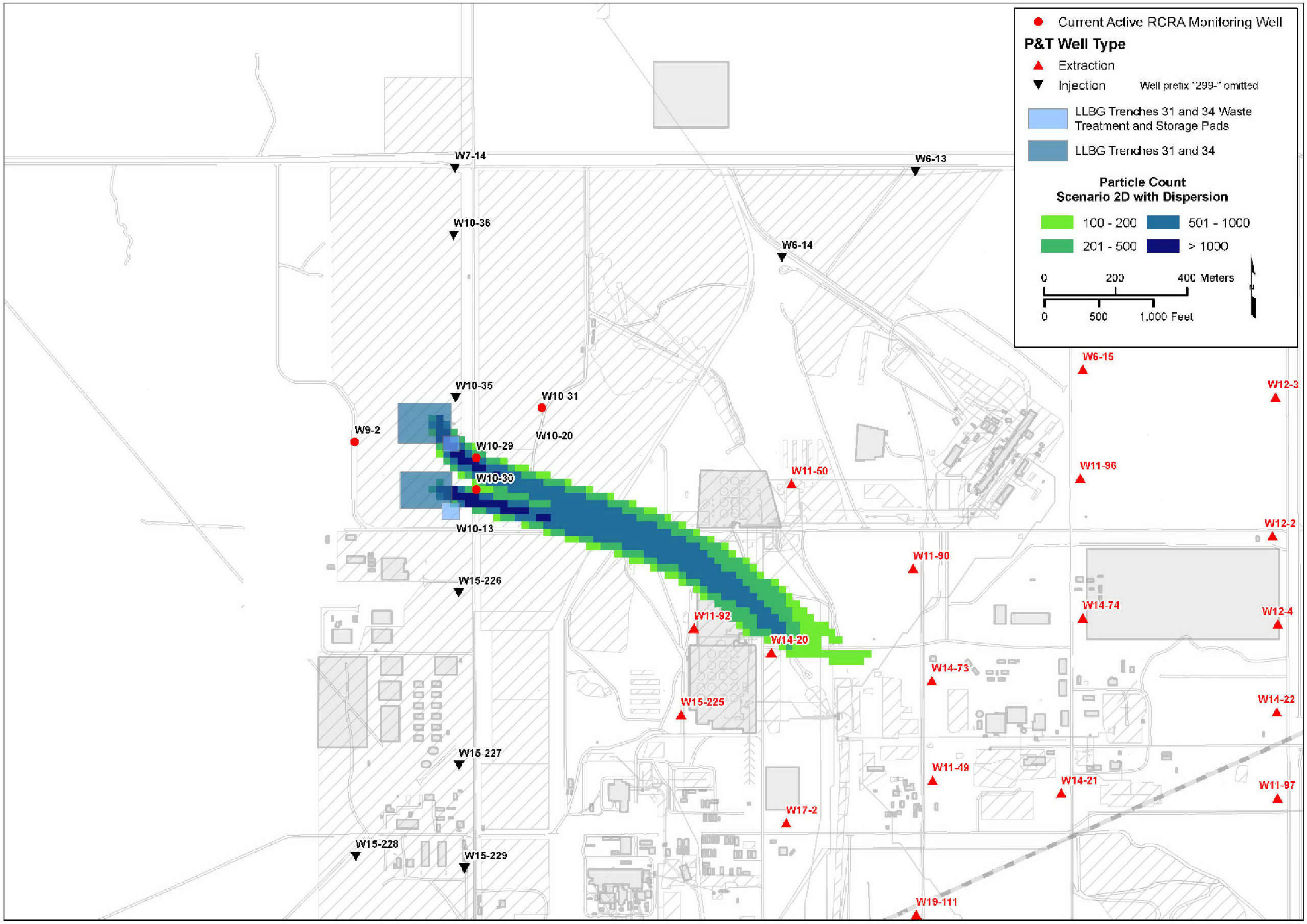

Figure C-10. Particle Count Scenario 2D with Dispersion

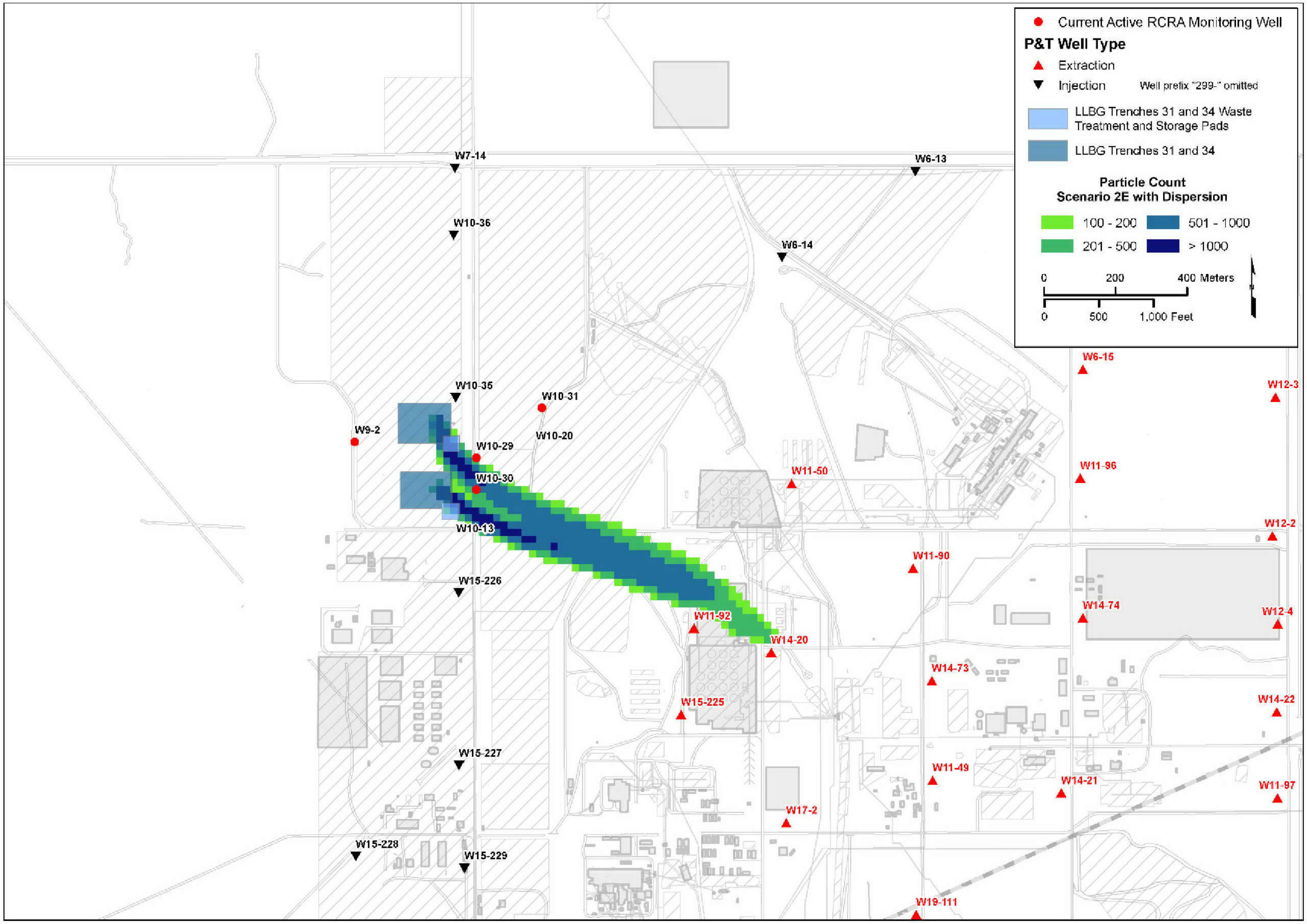

Figure C-11. Particle Count Scenario 2E with Dispersion

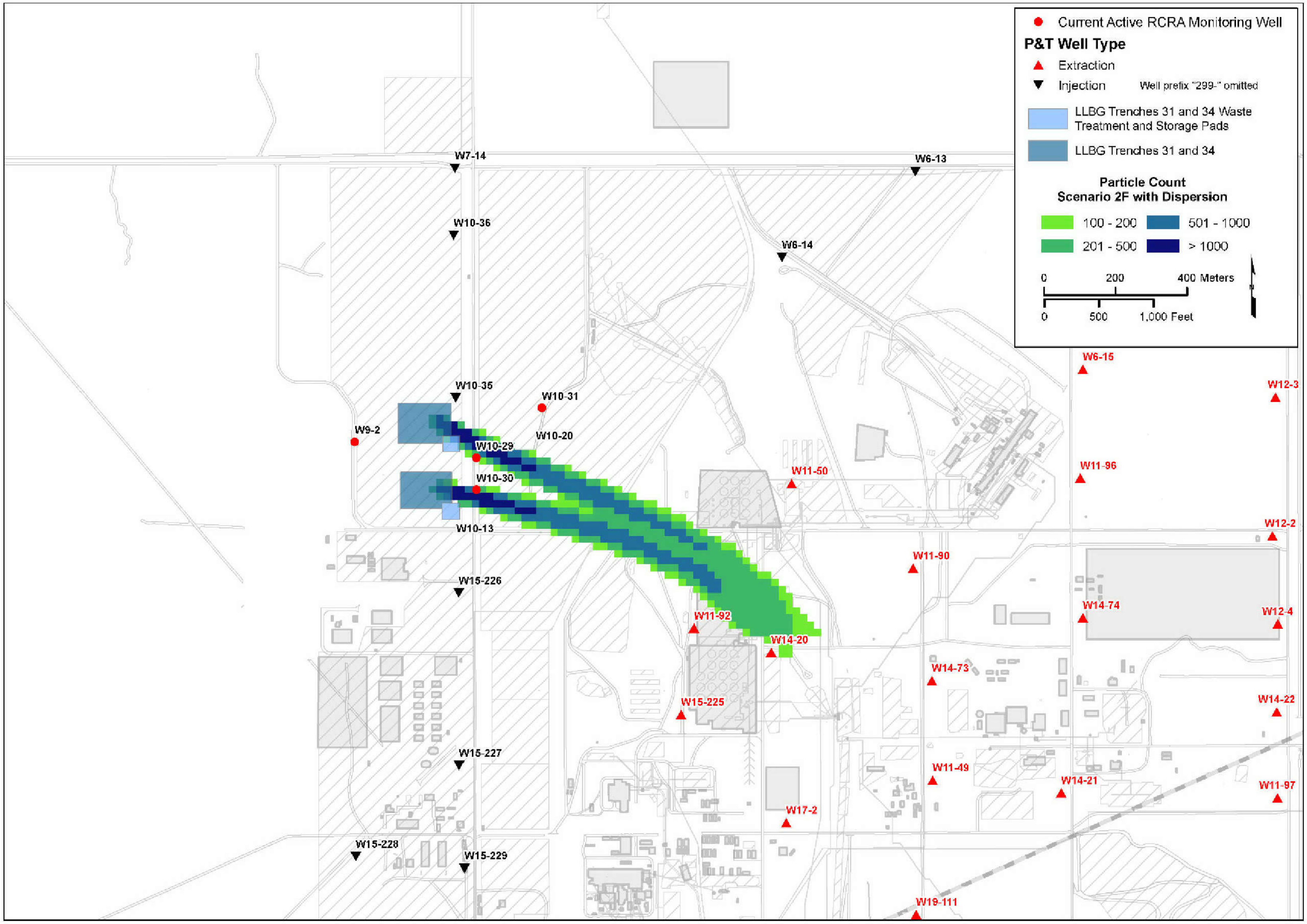

Figure C-12. Particle Count Scenario 2F with Dispersion

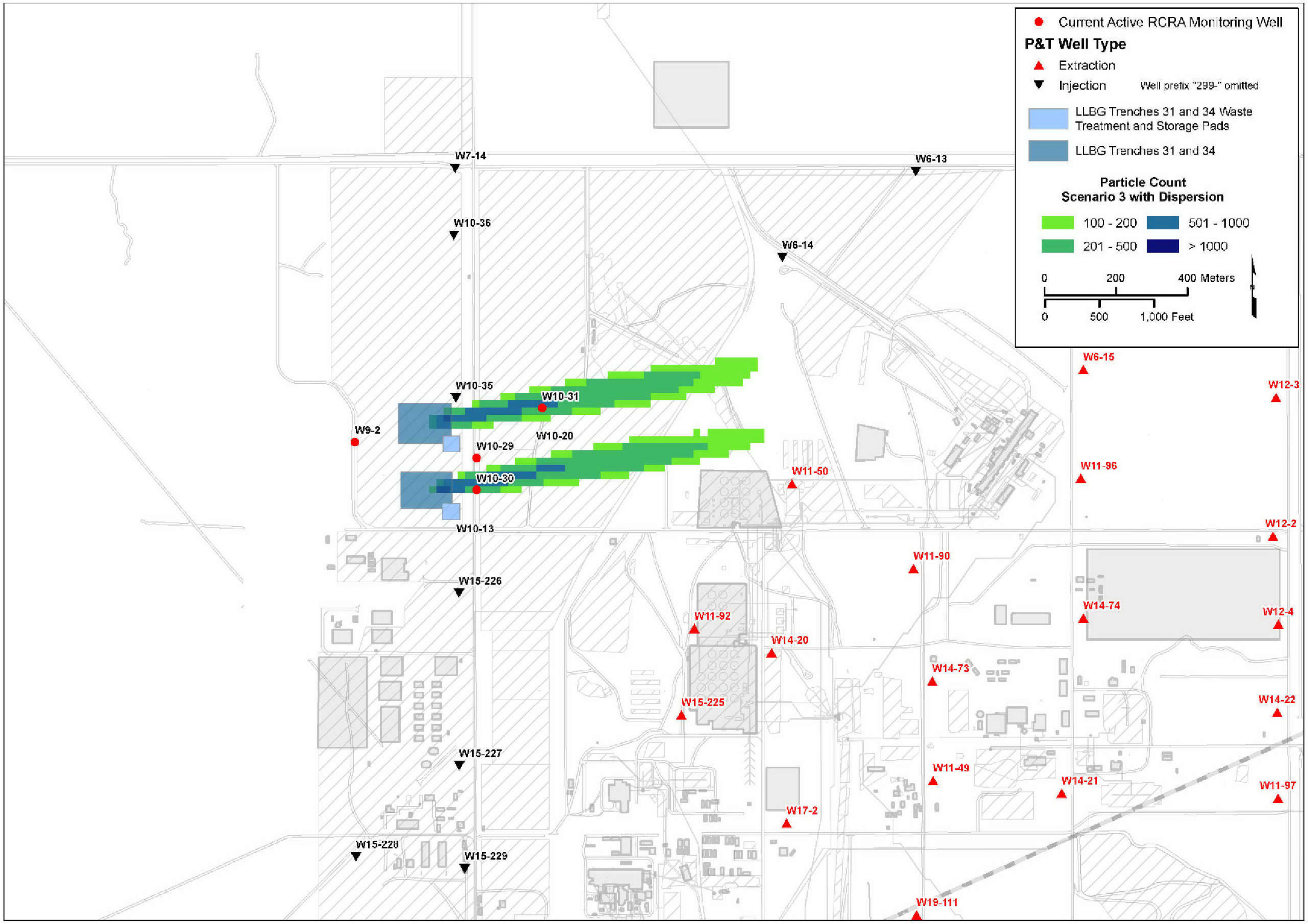

Figure C-13. Particle Count Scenario 3 with Dispersion

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